U. S. DEPARTMENT OF COMMERCE

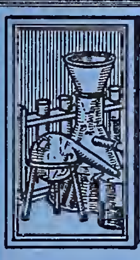
BUILDING MATERIALS AND STRUCTURES

REPORT BMS31

Structural Properties of "Insulite" Wall and "Insulite" Partition Constructions Sponsored by The Insulite Co.

by

HERBERT L. WHITTEMORE
and AMBROSE H. STANG
with the collaboration of
THOMAS R. C. WILSON
Forest Products Laboratory



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The Forest Products Laboratory of the United States Department of Agriculture is cooperating with both committees on investigations of wood constructions.

[For list of BMS publications and how to purchase, see cover page III.]

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THOMAS R. C. WILSON
Forest Products Laboratory
Forest Service, United States Department of Agriculture

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Foreword

This report is one of a series issued by the National Bureau of Standards on the structural properties of constructions intended for low-cost houses and apartments. These constructions were sponsored by industrial organizations advocating and promoting their use. The sponsor built and submitted specimens described in this report for the program outlined in BMS2, Methods of Determining the Structural Properties of Low-Cost House Constructions. The sponsor, therefore, is responsible for the description of the specimens and the method of fabrication. The Bureau is responsible for the method of testing and the test results.

This report covers only the load-deformation relations and strength of the structural elements when subjected to compressive, transverse, impact, concentrated, and racking loads by standardized methods simulating the loads to which the element would be subjected in actual service. Later it may be feasible to determine the heat transmission at ordinary temperatures and the fire resistance of these same constructions and perhaps other properties.

The National Bureau of Standards does not "approve" a construction, nor does it express an opinion as to the merits of a construction for the reasons given in reports BMS1 and BMS2. The technical facts on these and other constructions provide the basic data from which architects and engineers can determine whether a construction meets desired performance requirements.

Lyman J. Briggs, *Director.*

Structural Properties of "Insulite" Wall and "Insulite" Partition Constructions Sponsored by The Insulite Co.

by HERBERT L. WHITTEMORE *and* AMBROSE H. STANG

with the collaboration of THOMAS R. C. WILSON, Forest Products Laboratory, Forest Service, United States Department of Agriculture

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ABSTRACT

For the program on the determination of the structural properties of low-cost house constructions, The Insulite Co. submitted 114 specimens representing 6 wall and 2 partition constructions having wood framing with "Bildrite" sheathing, "Graylite" interior board, and "Lok-Joint" lath.

The wall specimens were subjected to compressive, transverse, concentrated, impact, and racking loads and the partition specimens to impact and concentrated loads. The transverse, concentrated, and impact loads were applied to both faces of wall specimens. For each of these loads three like specimens were tested. The deformation under load and the set after the load was removed were measured for uniform increments of load, except for concentrated loads, for which the set only was determined. The results are presented in graphs and in tables.

I. INTRODUCTION

In order to provide technical facts on the performance of constructions which might be used in low-cost houses, to discover promising constructions, and ultimately to determine the properties necessary for acceptable performance, the National Bureau of Standards has invited the building industry to cooperate in a program of research on building materials and structures for use in low-cost houses and apartments. The objectives of this program are described in report BMS1, Research on Building Materials and Structures for Use in Low-Cost Housing, and that part of the program relating to structural properties in report BMS2, Methods of Determining the Structural Properties of Low-Cost House Constructions.

Masonry constructions and wood constructions which have been extensively used in this country for houses were included in the program for the determination of the structural properties by the standardized laboratory methods described in BMS2 because their behavior under widely different service conditions is known to both builders and the public. The reports on these constructions are BMS5, Structural Properties of Six Masonry Wall Constructions, and BMS25, Structural Properties of Conventional Wood-Frame Constructions for Walls, Partitions, Floors, and Roofs. These wood-frame constructions were built and tested by the Forest Products Laboratory at Madison, Wis.

This report describes the structural properties of constructions sponsored by one of the manufacturers in the building industry. The specimens were subjected to compressive, transverse, concentrated, impact, and racking loads, simulating loads to which the elements of a house are subjected. In actual service, compressive loads on a wall are produced by the weight of the roof, second floor and second-story walls, if any, furniture and occupants, and snow and wind loads on the roof. Transverse loads on a wall are produced by the wind, concentrated and impact loads by furniture or accidental contact with heavy objects, and racking loads by the action of the wind on adjoining walls. For nonload-bearing partitions, impact loads may be applied accidentally by furniture or by a person falling against a partition, and concentrated loads by furniture or by a ladder or other object leaning against the partition.

The deformation and set under each increment of load were measured because, considered as a structure, the suitability of a wall or partition construction depends not only on its resistance to deformation when loads are applied but also on whether it returns to its original size and shape when the loads are removed.

II. SPONSOR AND PRODUCT

The specimens were submitted by The Insulite Co., Minneapolis, Minn., and represented wood-frame wall and partition constructions with "Bildrite" sheathing, "Graylite" interior board, and "Lok-Joint" lath. The wood-fiber insulating board was manufactured by The Insulite Co. and marketed under the trade names "Bildrite" sheathing, "Graylite" interior board, and "Lok-Joint" lath.

The wood framing was red pine, No. 1 common. The wall constructions had nominal 2- by 4-in. studs spaced 1 ft. 4 in. on centers, fastened to a single floor plate and a double top plate. The framing of the partition constructions was similar to that of the wall constructions, with the exception that the top plate was single, not double.

The outside face of the wall constructions was "Bildrite" sheathing covered with wood bevel siding, stucco, brick veneer, or wood shingles. The inside face of the wall constructions and both faces of the partition constructions were either "Graylite" interior board or "Lok-Joint" lath and gypsum plaster.

III. SPECIMENS AND TESTS

The six wall constructions and the two partition constructions were assigned the symbols given in table 1. The specimens were assigned the designations given in table 2.

TABLE 1.—*Construction symbols*

Element	Construction symbol	Outside face	Inside face
Wall	*BG*	"Bildrite" sheathing and wood bevel siding.	"Lok-Joint" lath and plaster.
Do	*BH*	do	"Graylite" interior board, ¾ in. thick.
Do	*BI*	do	"Graylite" interior board, ½ in. thick.
Do	*BJ*	"Bildrite" sheathing, sheathing paper, metal lath, and stucco.	"Lok-Joint" lath and plaster.
Do	*BK*	"Bildrite" sheathing and brick veneer.	Do.
Do	*BL*	"Bildrite" sheathing, wood furring strips, and wood shingles.	Do.
		Both faces	
Partition	*BM*	"Lok-Joint" lath and plaster.	
Do	*BN*	"Graylite" interior board. ½ in. thick.	

TABLE 2.—*Specimen designations*

Element	Specimen designation	Load	Load applied
Wall	*C1, C2, C3*	Compressive	Upper end.
Do	*T1, T2, T3*	Transverse	Inside face.
Do	*T4, T5, T6*	do	Outside face.
Do	*P1, P2, P3* [a]	Concentrated	Inside face.
Do	*P4, P5, P6* [a]	do	Outside face.
Do	*I1, I2, I3*	Impact	Inside face.
Do	*I4, I5, I6*	do	Outside face.
Do	*R1, R2, R3*	Racking	Upper end.
Partition	*I1, I2, I3*	Impact	Either face.
Do	*P1, P2, P3* [a]	Concentrated	Do.

[a] These specimens were undamaged portions of either the transverse or the impact specimens.

The specimens were tested in accordance with BMS2, Methods of Determining the Structural Properties of Low-Cost House Constructions, which also gives the requirements for the specimens and describes the presentation of the results of the tests, particularly the load-deformation graphs. Thomas R. C. Wilson of the Forest Products Laboratory, Madison, Wis., cooperated with the Bureau staff in this work by giving advice and suggestions on the technique of testing wood structures.

For the compressive test the thickness of the wall was taken as the thickness of the structural portion, that is, the distance from the inside surface of the studs to the outside surface of the studs. The compressive load was applied one-third this thickness from the inside surface of the studs. The shortenings and sets were measured by means of compressometers attached to the steel loading plates through which the load was applied to the specimen, not to the specimen as described in BMS2. For wood-frame constructions under compressive load there is considerable local shortening caused by crushing of the floor plate and the top plate at the ends of the studs. Therefore, the shortening of the entire specimen is not proportional to the value obtained from compressometers attached near each end of the specimen.

Before applying the loads, the speed of the movable head of the testing machine was measured under no load. For compressive loading the speed was 0.3 in./min. For transverse loading the speed was 0.44 in./min, except for the *BK* specimens. The transverse load was applied to the *BK* specimens by means of a jack operated manually, and the speed could not be closely regulated.

Each *BG*, *BL*, and *BM* specimen was tested on the 28th day following the application of the finish coat of plaster. Each *BJ* specimen was tested on the 28th day after completion of the stucco and the application of the finish coat of plaster. Each *BK* specimen was tested on the 28th day after completion of the brick veneer and the application of the base coat of plaster. For these *BK* specimens the age of the base coat when the finish coat of plaster was applied ranged from 6 to 14 days.

The tests were begun July 23, 1938, and completed October 25, 1938. The sponsor's representative witnessed the tests.

IV. MATERIALS

1. SOURCES OF INFORMATION

Sponsor's statement.—Unless otherwise stated, the information on materials was obtained from the sponsor and from inspection of the specimens.

Forest Products Laboratory.—The species of all the woods and also the grade of the wood framing were determined by the Forest Products Laboratory. The Laboratory also supervised the determination of the moisture content of the wood.

Paper Section.—The physical properties of the sheathing, interior board, and lath were determined by the Paper Section of the Bureau.

Lime and Gypsum Section.—The properties of the plaster were determined by the Lime and Gypsum Section of the Bureau.

Masonry Construction Section.—The properties of the stucco, brick, and mortar were determined by the Masonry Construction Section of the Bureau.

2. Wood

(a) *Framing*

Studs, floor plates, and top plates, red pine (*Pinus resinosa*, usually designated Norway pine), No. 1 common, S4S (surfaced four sides), 1⅝ by 3⅝ in. (nominal 2 by 4 in.).

(b) *Bevel Siding*

Northern white pine, select, grade B or better, 7/16 by 3/16 by 5½ in., 4 ft 0 in. long.

(c) *Nailing Strips*

Red pine (*Pinus resinosa*), No. 2 common, S2S (surfaced two sides), ¾ by ¾ in.

(d) *Furring Strips*

Red pine (*Pinus resinosa*), No. 2 common, S2S1E (surfaced two sides, one edge), ¾ by 1⅝ in., 4 ft 0 in. long.

(e) *Shingles*

Western red cedar, grade No. 1 (100 percent edge grain, 100 percent heart, 100 percent clear), 16 in. long, five butts to 2 in., dried by air. Brand "Highland."

Forest Products Laboratory.—After each specimen was tested, one face was removed to expose the studs and photographs were taken showing the knots and failures. The grade of the wood framing was determined from these photographs. The studs ranged from almost straight grain with few knots, as shown in figure 1, to many knots, as shown in figure 2. A typical frame is shown in figure 3.

The moisture content of all the wood (except the nailing strips) is given in table 3.

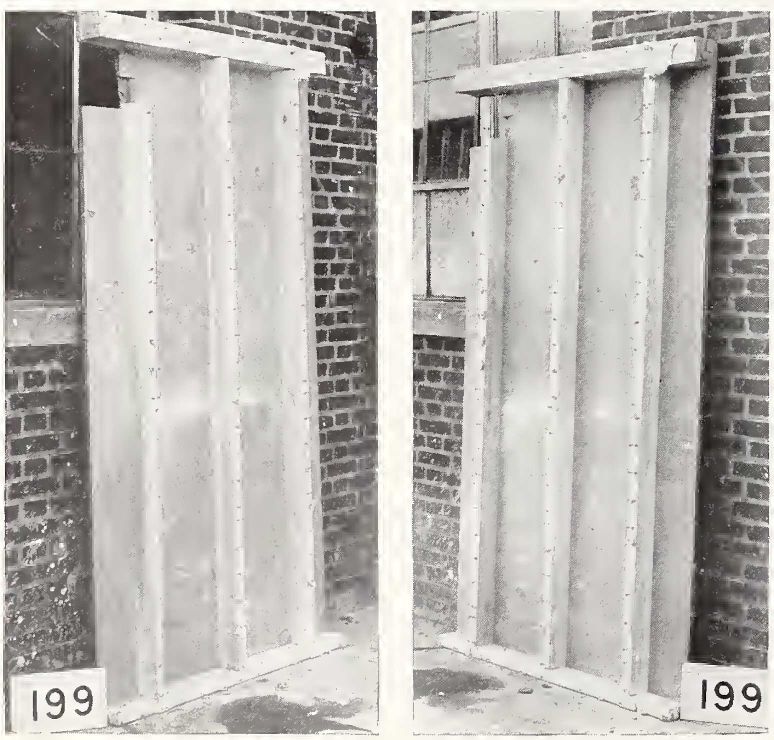

Figure 1.—*Frame of wall specimen BK-I4.*

Almost straight grain with few knots.

FIGURE 2.—*Frame of wall specimen BJ–T5.*

Many knots.

TABLE 3.—*Moisture content of the wood*

[Determined on the day the wall or partition specimen was tested]

Wood	Construction symbol	Moisture content [a] Minimum	Maximum	Average
		Percent	*Percent*	*Percent*
Framing, red pine	*BG*	11	15	12
	BH	9	14	12
	BI	9	15	12
	BJ	11	19	13
	BK	9	21	16
	BL	10	15	12
	BM	11	17	15
	BN	11	12	11
Average				13
Bevel siding, northern white pine	*BG*	10	12	11
	BH	8	12	11
	BI	8	12	11
Average				11
Furring strips, red pine	*BL*	9	12	10
Shingles, western red cedar	*BL*	8	10	9

[a] Based on the weight when dry.

An electrical moisture meter was used when determining the moisture content. Although the instructions with the meter gave correction values for several species of wood, there was none for red pine (Norway pine). Therefore, 44 samples from the frames were dried in an oven at 212° F until the weight was constant. The moisture content was the difference between the initial weight and the weight when dry, divided by the weight when dry. The average value for these samples was 0.7 greater than the average of the meter readings; therefore, the moisture content of the red pine was obtained by adding 0.7 to the meter readings and rounding the result to the nearest whole number.

The moisture content of the wood in each specimen was determined on each stud. If the construction included these materials, it was determined on about one-half of the pieces of bevel siding and on 4 furring strips and about 10 shingles.

3. INSULATING BOARD

(a) *General*

All the insulating boards were made from wood fibers produced by a cold-grinding process and felted into a board. The fibers were chemically treated to increase the water resistance and to resist rot and termites. One surface of the boards had the appearance of closely woven fabric, designated "linen tex-

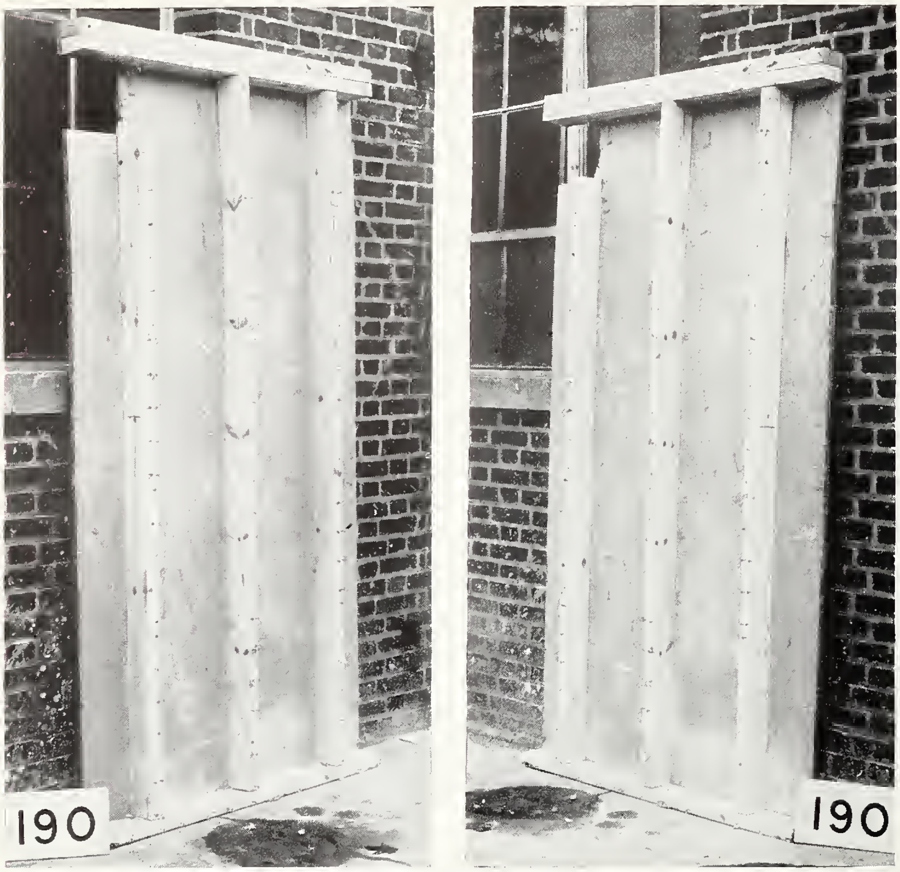

FIGURE 3.—*Frame of wall specimen BK–T5.*

A typical frame.

ture"; the other surface had the appearance of loosely woven fabric, designated "burlap texture."

(*b*) *"Bildrite" Sheathing*

Rigid insulating board, 25/32 in. thick, made as described under (*a*), with the exception that the wood fibers were intimately mixed with finely divided asphalt before felting. The asphalt was added to increase the strength and water resistance. Color, grayish brown. The recommended location for nails was marked on the linen-textured surface.

(*c*) *"Graylite" Interior Board*

Rigid insulating board, 1/2 and 3/4 in. thick, made as described under (*a*), with the exception that asphalt was added as for "Bildrite" sheathing. Color, grayish brown.

(*d*) *"Lok-Joint" Lath*

Rigid insulation board made as described under (*a*), 1/2 in. thick, 1 ft 6 in. by 4 ft 0 in., shiplapped along each of the longer edges as shown at *A*, figure 4. There were three "Loks," spaced about 1 ft 4 in. on one shiplapped edge of each lath. The "Lok," *B*, was a loop of galvanized steel wire, No. 12 (0.1055-in. diam before galvanizing), reinforced by a staple, *C*, of steel wire No. 19 (0.041-in. diam). The "Loks" were attached to the lath to prevent lateral displacement with respect to the adjacent lath, particularly when the plaster was applied.

Paper Section.—The physical properties of the sheathing, interior board, and lath are given in table 4.

The samples of the boards were taken from the specimens after they had been tested. Probably the properties of the lath were affected by the removal of the plaster.

Table 4.—*Physical properties of the sheathing, interior board, and lath*

[The samples were taken from the specimens after they had been tested]

Board	Thickness	Specimen	Transverse				Tensile strength		Water absorption, by volume	Linear expansion for 47 percent relative humidity change	Density, dry	Air permeability	Nail-holding strength	
			Strength		Deflection at ultimate load		Lengthwise	Crosswise					Lengthwise	Crosswise
			Lengthwise	Crosswise	Lengthwise	Crosswise								
	in.		*lb*	*lb*	*in.*	*in.*	*lb/in.*^{2}	*lb/in.*^{2}	*Percent*	*Percent*	*lb/ft*^{3}	$\frac{ft^3/hr}{ft^2\ (lb/in.^2)}$	*lb*	*lb*
"Bildrite" sheathing.	25/32	*BG-T2*	53.3	47.6	0.51	0.52	344	294	5.4	0.2	17.1		158	146
		BH-R1	57.0	53.1	.47	.49			4.2	.2	18.2	267	144	145
		BI-T1	61.2	53.6	.47	.51		304	3.7	.1	18.4	234	156	146
		BJ-T4	55.0	50.1	.56	.54	355	329	5.5	.3	17.1		157	157
		BK-T2	57.8	48.1	.48	.63	367	305	5.0	.2	17.3		156	147
		BL-C3	54.8	50.7	.48	.42	381	335	5.5	.2	17.1		157	147
Average			56.5	50.5	0.50	0.52	362	313	4.9	0.2	17.5	250	155	148
"Graylite" interior board.	3/4	*BH-R1*	62.6	52.4	0.50	0.52			3.7	0.2	18.2	230	150	148
Do	1/2	*BI-T1*	26.0	21.2	0.64	0.74	352	286	4.8	0.2	17.5	184	89	85
		BN-I3	24.3	21.8	.62	.63	383	305	4.7	.3	17.6	211	106	101
Average			25.2	21.5	0.63	0.68	368	296	4.8	0.2	17.6	198	98	93
"Lok-Joint" lath	1/2	*BG-T2*	18.0	12.3	0.75	0.90	225	233	6.6	0.4	14.2		58	62
		BJ-T4	17.6	13.8	.74	.90	214	311	6.9	.3	14.7		62	63
		BK-T2	18.7	12.3	.74	1.05	208	267	6.4	.4	14.6		62	56
		BL-C3	14.9	13.0	.69	0.94	211	269	6.5	.3	14.6		58	63
		BM-I3	17.7	14.0	.69	.92	233	285	6.6	.2	15.0		61	61
Average			17.4	13.1	0.72	0.94	218	273	6.6	0.3	14.6		60	61

The transverse strength and deflection at ultimate load, tensile strength, water absorption, and linear expansion were determined in accordance with Federal Specification LLL–F–321a, Fiber-Board; Insulating. For these properties the sheathing and the building board complied with the requirements for class A. For these properties, except for the deflection at ultimate load of the crosswise specimen, the lath complied with the requirements for class B. In the crosswise specimen the deflection exceeded the specified maximum of 0.85 in.

The air permeability given in table 4 was determined with the apparatus developed by F. T. Carson.[1] The nail-holding strength was measured by the method described in BMS4, Accelerated Aging of Fiber Building Boards, with the exception that the nails, common, 6d, 2 in. long, No. 11½ steel wire (0.113-in. diam), were ½ in., not ¾ in., from the edge of the board. A distance of ½ in. was used because this was approximately the distance in the wall and partition specimens.

The moisture content of the sheathing, interior board, and lath, determined by oven-

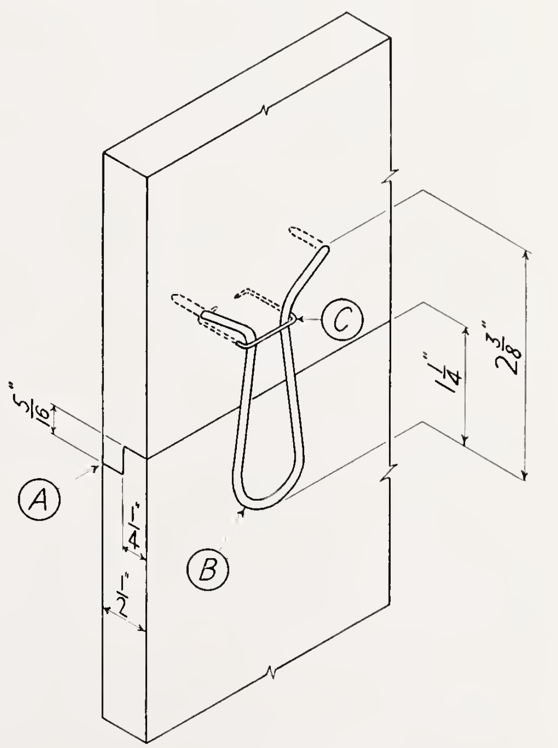

Figure 4.—*"Lok-Joint" lath.*

A, shiplapped joint; *B*, "Lok" with prongs projecting into the lath; *C*, staple passing through the lath and clinched.

[1] BS J. Research 12, 567 (1934) RP681.

drying at 212° F to constant weight, is given in table 5.

TABLE 5.—*Moisture content of the sheathing, interior board, and lath*

[Determined on the day the wall or partition specimen was tested]

Board	Thickness	Specimen	Moisture content [a]		
			Minimum	Maximum	Average
	in.		*Percent*	*Percent*	*Percent*
"Bildrite" sheathing	25/32	*BG–T2*	8	10	9
		BH–R1	6	9	8
		BI–T1	7	9	8
		BJ–T4	9	14	11
		BK–T2	7	14	11
		BL–C3	7	9	8
Average					9
"Graylite" interior board	3/4	*BH–R1*	6	10	8
Do	1/2	*BI–T1*	7	9	8
		BN–I3	8	10	9
Average					8
"Lok-Joint" lath	1/2	*BG–T2*	10	14	12
		BJ–T4	10	15	11
		BK–T2	9	22	14
		BL–C3	9	13	11
		BM–I3	13	15	14
Average					12

[a] Based on the weight when dry.

4. NAILS

The nails were made from steel wire, and the description is given in table 6.

TABLE 6.—*Description of nails*

Type	Size	Length	Steel wire gage		Head diam	Finish
	Penny	*in.*	*Number*	*diam, in.*	*in.*	
Box	6	1⅞	13½	0.0858		Cement coated.
Do	10	2⅞	11½	.1130		Do.
Common	3	1¼	14	.0800		Galvanized.
Do	8	2½	10¼	.1314		
Do	10	3	9	.1483		
Do	16	3½	8	.1620		
Finishing	4	1½	15	.0720		
Do	6	2	13	.0915		
Plasterboard		1¼	13	.0915	5/16	Blued.
Roofing		1½	10	.1350	⅜	Zinc coated.
Do		1⅜	9½	.1417	½	Do.

5. PLASTER

The plaster was applied in two coats. The base coat was 1 part of neat gypsum plaster and 2 parts of Potomac River building sand, by weight. The finish coat was 1 part of gaging plaster and 3 parts of hydrated finishing lime, by volume. The neat gypsum plaster, the gaging plaster, and the finishing lime were United States Gypsum Co.'s "Red Top." The plastering contractor was instructed to apply the plaster to the specimens as he would to the walls and partitions of a house.

Lime and Gypsum Section.—The properties of the plaster were determined in accordance with Federal Specification SS–P–401, Plaster; Gypsum. The time of set of the neat gypsum plaster for batches 1 to 20, inclusive, was 5½ hr, and the tensile strength was 250 lb/in². The time of set of the neat gypsum plaster for batches 21, 22, and 23 was 15 hr, and the tensile strength was 270 lb/in². Accelerator was added to batches 21, 22, and 23 to decrease the time of set to about 5½ hr. The neat gypsum plaster complied with the requirements for time of set and tensile strength in the Federal specification.

The tensile strength of the sanded plaster for the base coat was determined on samples of each batch of the wet plaster taken from the job. The plaster was cast in briquet molds and cured in accordance with paragraph F–2f (1) of Federal Specification SS–P–401, Plaster; Gypsum. The tensile strength of the sanded plaster is given in table 7.

TABLE 7.—*Tensile strength of the sanded plaster*

[Determined when weight was constant within 0.1 percent]

Batch number	Specimens [a]	Tensile strength
		lb/in².
1	*BG–C1, T1, T2, R1*	
2	*BG–T3, I1 (P1), I2 (P2), R2*	110
3	*BG–T4, I3 (P3), I4, R3*	95
4	*BG–C2, T5, I5*	110
5	*BG–C3, T6; BL–T1*	105
6	*BG–I6; BL–R1, R2*	80
7	*BL–T2, T3, I1 (P1), I2 (P2)*	90
8	*BL–C1, T4, I3 (P3), I4*	125
9	*BL–T5, I5, R3*	105
10	*BL–C2, C3, T6, I6*	105
11	*BM–I1 (P1), I2 (P2), I3 (P3)*	110
12	*BJ–C1, T1, T2*	135
13	*BJ–C2, C3, T3, T4, T5, I1 (P1), I2 (P2)*	130
14	*BJ–T6, I3 (P3), I4, R1*	115
15	*BJ–R2*	130
16	*BJ–I5, I6, R3*	145
17	*BK–C1, T1 (P1), T2 (P2)*	140
18	*BK–C2, T3 (P3), T4*	155
19	*BK–C3, T5, T6*	130
20	*BK–I1, I2, I3*	90
21	*BK–I4, I5*	190
22	*BK–I6, R1*	155
23	*BK–R2, R3*	190

[a] The concentrated-load specimens shown in parentheses were undamaged portions of either the transverse or the impact specimens immediately preceding.

The tensile strength of different batches of the sanded plaster varied principally with the quantity of water in the plaster mix, as indicated by the differences between batch 20 and batch 21. For batch 20 the slump was 1¼ in. and the tensile strength 90 lb/in². For batch 21 the slump was 3⅜ in. (less water) and the tensile strength 190 lb/in².

There are no requirements in the Federal specification for the tensile strength of sanded plaster which has been sanded on the job. The tensile strength of each batch exceeded the specified minimum tensile strength for ready-sanded, scratch-coat plaster.

The proportions of plaster and sand in the set plaster were determined for two batches in accordance with the proposed revision, 1938, of Methods of Testing Gypsum and Gypsum Products, American Society for Testing Materials, Designation C26–33. The ratio was 1 part of plaster to 2 parts of sand, by weight.

The time of set, the proportions of plaster and sand in the base coat, and the thickness of the plaster complied with the recommendations for two-coat plastering in BMS3, Suitability of Fiber Insulating Lath as a Plaster Base. No buckles or cracks were observed in any of the specimens.

6. Stucco Finish

(a) *Stucco*

The materials for the stucco were Standard Lime and Stone Co.'s "Capitol" portland cement, lime putty made by slaking Standard Lime and Stone Co.'s "Washington" powdered quicklime, and coarse Potomac River building sand (maximum size 3/16 in.).

The stucco was 1 part of portland cement, 0.11 part of hydrated lime, and 2.72 parts of dry sand, by weight. The proportions by volume were 1 part of cement, 0.25 part of hydrated lime, and 3.2 parts of loose damp sand, assuming that portland cement weighs 94 lb/ft^3, dry hydrated lime 40 lb/ft^3, and 80 lb of dry sand are equivalent to 1 ft^3 of loose damp sand. The materials for each batch were measured by weight, corrections being made for the moisture content of the lime putty and the sand. The stucco was hand-mixed in a mortar box, using either one or two bags of cement to the batch.

The stucco was applied in three coats, each coat being at least 1/4 in. thick, giving a total thickness of about 1 in. The second coat was applied 1 day after the first coat, and the third, 3 days after the second. The first two coats were scratched thoroughly. The third coat was rubbed down with a wood-shingle float about 1/2 hr after being screeded. The specimens were covered with wet burlap for 1 day after the application of each coat, and the finish coat was sprinkled with water daily for about 7 days.

Masonry Construction Section.—The cement complied with the requirements of Federal Specification SS–C–191a, Cement; Portland, for fineness, soundness, time of setting, and tensile strength. The lime putty contained about 40 percent of dry hydrate, by weight, and had a plasticity of over 600, measured in accordance with Federal Specification SS–L–351, Lime; Hydrated (for) Structural Purposes. The sieve analysis of the sand is given in table 8.

Table 8.—*Sieve analysis of the sand for the stucco, wall BJ*

Sieve number, U. S. Standard	Passing, by weight	Sieve number, U. S. Standard	Passing, by weight
	Percent		*Percent*
4	99	30	48
8	88	50	9
16	74	100	1

One or more samples were taken from each batch of stucco, the flow was determined in accordance with Federal Specification SS–C–181b, Cement; Masonry, and six 2-in. cubes were made. Three cubes were stored in water at 70° F and three in air near the wall specimens. The physical properties of the stucco are given in table 9.

Table 9.—*Physical properties of the stucco, wall BJ*

Batch	Specimens			Flow	Compressive strength [a]	
	1st coat	2nd coat	3rd coat		Air storage	Water storage
				Percent	*lb/in.²*	*lb/in.²*
1	*C1, T1, T2*			131	1,490	3,580
2	*C2, T3, T4*	*C1, T1, T2*		114	2,890	4,615
3	*C3, T5, I1, I2*			118	2,655	4,960
4		*C2, C3, T3, T4, T5, I1, I2.*		102	2,375	4,025
5	*T6, I3, I4(P4), R1.*			108	2,700	4,660
6			*C1, T1, T2*	124	2,715	4,240
7		*T6, I3, I4 (P4)*		118	2,370	3,860
8	3/4 of *R2*	*R1*		120	2,740	4,580
9	1/4 of *R2*			133	2,490	4,080
10		*R2*	*C2, T3, T4*	110	2,340	4,325
11			*C3, T5. I1, I2*	121	2,010	4,280
12	*I5 (P5), I6 (P6).*			112	1,710	3,950
13	*R3*			117	1,925	4,425
14		*I5 (P5), I6 (P6), R3.*	*T6, I3. I4 (P4)*	150	1,890	3,460
15			*R1*	150	1,775	3,545
16			*R2*	111	3,425	4,600
17			*R3*	125	2,645	4,775
18			*I5 (P5), I6 (P6).*	115	2,430	4,375

[a] Determined on the day the specimen was tested.

The average water content of the stucco mix was 17.5 percent by weight of the dry materials.

(b) *Sheathing Paper*

Felted-paper base, saturated with tar; weight, 60 lb/432 ft^2; width of roll, 2 ft 8 in. The Barrett Co.'s "Black Diamond," No. 14.

(c) *Metal Lath*

Self-furring, expanded metal, 9/32- by 15/32-in. diamond mesh, formed from sheet steel, No. 24 U. S. Std. Gage (0.0245 in. thick), zinc coated; weight, 3.4 lb/yd^2; width of sheets, 3 ft 4 in. Milcor Steel Co.'s "Smalmesh."

(d) *Staples*

Fence staples, 1¾ in. long, made from steel wire, No. 9 gage (0.148-in. diam), zinc coated.

(e) *Wire*

Steel, No. 18 gage (0.0475-in. diam before galvanizing), zinc coated.

7. Brick Veneer

(a) *Brick*

The brick were No. 1 common red, selected, made by West Bros. Brick Co., Arlington, Va. The brick were of clay formed by the stiff-mud, side-cut process. The average dimensions were 8.37 by 3.80 by 2.28 in. (about 8⅜ by 3 13/16 by 2 9/32 in). There were three ⅝-in. holes through each brick, spaced 1½ in. on centers symmetrically along the lengthwise center line.

Masonry Construction Section.—The physical properties of the brick are given in table 10.

Table 10.—*Physical properties of the brick, wall BK*

Compressive strength	Modulus of rupture	Water absorption by total immersion: 5-hr cold	24-hr cold, C	5-hr boil, B	Saturation coefficient, B/C	Water absorption by partial immersion,[a] 1-min: Dry	As laid	Weight, dry
lb/in.^{2}	*lb/in.*^{2}	*Percent*	*Percent*	*Percent*		*Grams/brick*	*Grams/brick*	*lb/brick*
7,520	835	7.9	8.4	11.2	0.75	48	24	5.17

[a] Immersed on flat side in 1/8 in. of water.

The physical properties were determined in accordance with the ASTM Standard C67–37,[2] so far as this standard applied. The brick complied with the requirements of grade H, Federal Specification SS–B–656, Brick; Building (Common), Clay.

When the laying of the brick veneer was started, the water absorption for partial immersion for 1 min was between 10 and 20 grams/brick. The mason complained that the brick were too wet; and that the excess mortar from the bed joints dropped into the cavity behind the veneer and pushed the brick away from the sheathing. The brick were dried until the absorption was between 20 and 30 grams/brick.

(b) *Mortar*

The materials for the mortar were Standard Lime and Stone Co.'s "Capitol" portland cement, lime putty made by slaking Standard Lime and Stone Co.'s "Washington" powdered quicklime, and Potomac River building sand.

The mortar was 1 part of portland cement, 0.11 part of hydrated lime, and 2.6 parts of dry sand, by weight. The proportions by volume were 1 part of cement, 0.25 part of hydrated lime, and 3.2 parts of loose damp sand, assuming that portland cement weighs 94 lb/ft^3, dry hydrated lime 40 lb/ft^3, and 80 lb of dry sand are equivalent to 1 ft^3 of loose damp sand. The materials for each batch were measured by weight and mixed in a batch mixer having a capacity of ⅔ ft^3.

Masonry Construction Section.—The cement complied with the requirements of Federal Specification SS–C–191a for fineness, soundness, time of setting, and tensile strength. The lime putty contained about 40 percent of dry hydrate, by weight, and had a plasticity of over 600, measured in accordance with Federal Specification SS–L–351, Quicklime; (for) Structural Purposes. The sieve analysis of the sand is given in table 11.

Table 11.—*Sieve analysis of the sand for the mortar, wall BK*

Sieve number, U. S. Standard	Passing, by weight	Sieve number, U. S. Standard	Passing, by weight
	Percent		*Percent*
8	100	50	21
16	100	100	3
30	82		

[2] Am. Soc. Testing Materials Supplement to Book of ASTM Standards, p. 78–82 (1937).

Samples were taken from at least one batch of mortar for each wall specimen, the flow determined in accordance with Federal Specification SS–C–181b, and six 2-in. cubes were made. Three cubes were stored in water at 70° F and three stored in air near each specimen. The physical properties of the mortar are given in table 12.

TABLE 12.—*Physical properties of mortar, wall BK*

Batch	Specimens	Flow	Compressive strength [a]	
			Air storage	Water storage
		Percent	*lb/in.²*	*lb/in.²*
1	*C1, T1, T2*	111	2, 885	3, 800
2	*C2, T4*	112	2, 465	3, 640
3	*T3*	99	2, 145	3, 510
4	*C3, T5, T6*	123	1, 800	3, 610
5	*I2, I3*	125	2, 660	4, 010
6	*I1*	119	2, 390	3, 600
7	*I4, I5*	128	2, 535	3, 840
8	*I6, R1*	126	2, 600	3, 800
9	*R2, R3*	120	2, 645	4, 040
	Average	118	2, 460	3, 760

[a] Determined on the day the specimen was tested.

(c) *Wall Ties*

Corrugated sheet steel, 7 by ⅞ in., No. 26 U. S. Std. Gage (0.0184 in. thick), galvanized. Milcor Steel Co.

V. WALL *BG*

1. Description, Sponsor's Statement

This construction was a wood frame with "Bildrite" sheathing and wood bevel siding on the outside face; "Lok-Joint" lath and plaster on the inside face.

The price in Washington, D. C., as of July 1937, was \$0.33/ft².

(a) *Four-Foot Wall Specimens*

The 4-ft wall specimens were 8 ft 0 in. high, 4 ft 0 in. wide, and 6⅛ in. thick. Each specimen consisted of a wood frame to which the faces were fastened. The frame consisted of three studs, *A*, shown in figure 5, fastened to a floor plate, *B*, and a top plate, *C*, by nails. The outside face consisted of insulating-board sheathing, *D*, and wood bevel siding, *E*. The inside face consisted of wood nailing strips, *F*, insulating-board lath, *G*, and plaster, *H*. The specimens were not painted.

Studs.—The studs, *A*, were red pine, 1⅝ by 3⅝ in. (nominal 2 by 4 in.), 7 ft 7⅛ in. long, spaced 1 ft 4 in. on centers. The lower end of each stud was fastened to the floor plate by two 16d common nails driven from the bottom of the plate (not toenailed), and the upper end of

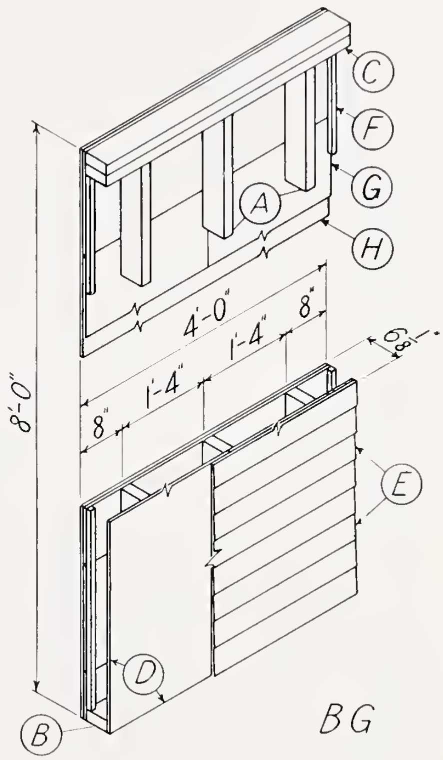

FIGURE 5.—*Four-foot wall specimen BG.*

A, stud; *B*, floor plate; *C*, top plate; *D*, sheathing; *E*, bevel siding; *F*, nailing strip; *G*, lath; *H*, plaster.

each stud was fastened to the top plate by two 16d common nails driven from the top of the lower member of the plate.

Floor plate.—The floor plate, *B*, was red pine, 1⅝ by 3⅝ in. (nominal 2 by 4 in.), 4 ft 0 in. long.

Top plate.—The top plate, *C*, consisted of two pieces of red pine, 1⅝ by 3⅝ in. (nominal 2 by 4 in.), 4 ft 0 in. long, fastened by ten 10d common nails uniformly spaced and driven from the top of the upper member of the plate.

Sheathing.—The sheathing, *D*, was two "Bildrite" sheathing boards, 25/32 in. by 1 ft 11 15/16 in., 8 ft 0 in. long, with the linen-textured surface outward. There was a vertical joint on the center stud with ⅛-in. clearance between the edges of the boards. The boards were fastened to the center stud, the floor plate, and the top plate by 8d common nails spaced 3 in., about ½ in. from the edges of the boards, and to the two outer studs by 8d common nails spaced 6 in.

Bevel siding.—The bevel siding, *E*, was 21 pieces of northern white pine, 7/16 by 3/16 by 5½ in., 4 ft 0 in. long, exposed 4½ in. to the weather, and fastened through the overlapping edges by 10d box nails, one at each stud.

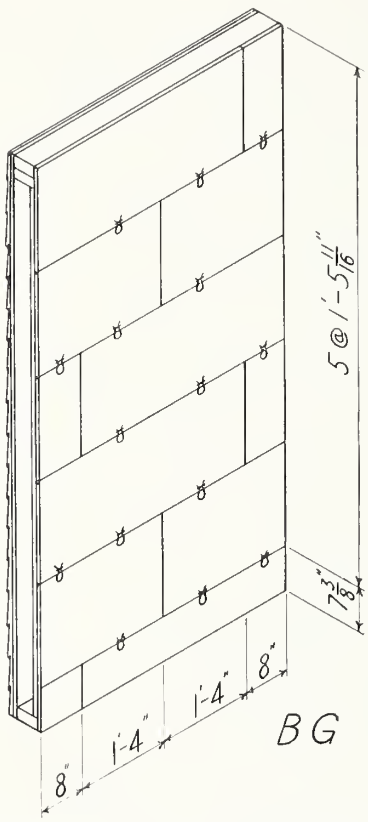

FIGURE 6.—*Four-foot wall specimen BG.*

Inside face, showing "Lok-Joint" lath.

Nailing strips.—The nailing strips, *F*, were red pine, ¾ by ¾ in., 7 ft 7 in. long. In the specimen they supported the outer edge of the lath to facilitate plastering, but they are not used in a house.

Lath.—The lath, *G*, consisted of "Lok-Joint" lath, five full courses and one course cut to a height of 7⅜ in., as shown in figure 6. The plaster was on the burlap-textured surface. There was a vertical joint in each course, centered on a stud, with 3/16-in. clearance between the edges of the lath. The horizontal joints (shiplapped) were reinforced by "Loks," three at each joint. The lath was fastened to the studs, floor plate, top plate, and nailing strips by plasterboard nails, spaced 4 in., about ½ in. from the edges of the lath.

Plaster.—The plaster, *H*, was ½ in. thick and consisted of a base coat and a finish coat. The lath was dry when the plaster was applied.

(*b*) *Eight-Foot Wall Specimens*

The 8-ft wall specimens were 8 ft 0 in. high, 8 ft 0 in. face width, and 6⅛ in. thick. The specimens were similar to the 4-ft specimens, with the exception that there were seven studs, spaced 1 ft 4 in. on centers and no nailing strips. There was a stud at each edge extending one-half its thickness beyond the faces, width over-all 8 ft 1⅝ in. The two members of the top plate were fastened by twenty 10d common nails, uniformly spaced.

Sheathing.—The sheathing consisted of two boards, 3 ft 11⅞ in. wide, having a vertical joint on the center stud with ⅛-in. clearance between the edges of the boards. The boards were fastened to the edge studs, center stud, floor plate, and top plate by 8d common nails spaced 3 in., about ½ in. from the edges of the boards, and to the other four studs by 8d common nails spaced 6 in.

2. Compressive Load

The results for wall specimens *BG–C1*, *C2*, and *C3* are shown in table 13 and in figures 7 and 8.

The lateral deflections shown in figure 8 were plotted to the right of the vertical axis for deflections of the specimens toward the outside face (positive deflection) and to the left for deflections toward the inside face (negative deflection).

Although the load was eccentric toward the inside face, each of the specimens deflected initially toward the inside face, probably because the stiffness of the plaster counteracted the effect of the eccentric load. As the maximum load was approached, the deflections toward the inside face decreased. At

Table 13.—*Structural properties of walls BG, BH, BI, BJ, BK, and BL*

Construction symbol	Weight	Load: Compressive [a] Specimen	Compressive [a] Maximum load	Transverse [b] Specimen	Transverse [b] Maximum load	Concentrated Specimen	Concentrated Maximum load	Impact [b] Specimen	Impact [b] Failure of loaded face, height of drop	Impact [b] Failure of opposite face, height of drop	Impact [b] Maximum height of drop	Racking Specimen	Racking Maximum load
	lb/ft²		[c] *Kips/ft*		*lb/ft²*		*lb*		*ft*		*ft*	*ft*		[c] *Kips/ft*
BG	8.80	*C1*	15.05	*T1*	305	*P1*	212	*I1*	1.5	([d])	[e] 10.0	*R1*	1.75
		C2	10.00	*T2*	373	*P2*	368	*I2*	2.5	([d])	[e] 10.0	*R2*	1.64
		C3	9.74	*T3*	400	*P3*	264	*I3*	2.5	([d])	[e] 10.0	*R3*	1.66
Average			11.60		359		281		2.2	([d])	[e] 10.0		1.68
BG				*T4*	350	*P4*	570	*I4*	([d])	4.0	[e] 10.0		
				T5	215	*P5*	549	*I5*	([d])	3.0	[e] 10.0		
				T6	422	*P6*	650	*I6*	9.5	3.0	[e] 10.0		
Average					329		590			3.3	[e] 10.0		
BH	5.02	*C1*		*T1*	327	*P1*	285	*I1*	([d])	([d])	[e] 10.0	*R1*	1.75
		C2	6.81	*T2*	300	*P2*	271	*I2*	9.5	([d])	[e] 10.0	*R2*	1.73
		C3	7.27	*T3*	293	*P3*	285	*I3*	([d])	7.5	[e] 10.0	*R3*	1.83
Average			7.04		306		280				[e] 10.0		1.77
BH				*T4*	343	*P4*	620	*I4*	([d])	7.0	[e] 10.0		
				T5	245	*P5*	704	*I5*	([d])	([d])	[f] 10.0		
				T6	269	*P6*	820	*I6*	([d])	7.0	[e] 10.0		
Average					286		715		([d])				
BI	4.51	*C1*	6.97	*T1*	319	*P1*	141	*I1*	9.0	9.0	[e] 10.0	*R1*	1.52
		C2	6.03	*T2*	233	*P2*	149	*I2*	7.0	7.0	9.0	*R2*	1.50
		C3	5.50	*T3*	258	*P3*	160	*I3*	10.0	([d])	[e] 10.0	*R3*	1.59
Average			6.17		270		150		8.7				1.54
BI				*T4*	250	*P4*	720	*I4*	7.0	6.0	[e] 10.0		
				T5	318	*P5*	620	*I5*	([d])	([d])	[f] 10.0		
				T6	318	*P6*	620	*I6*	([d])	9.0	[e] 10.0		
Average					295		653						
BJ	20.0	*C1*	8.55	*T1*	350	*P1*	318	*I1*	3.0	8.0	[e] 10.0	*R1*	2.00
		C2	9.25	*T2*	400	*P2*	275	*I2*	4.5	([d])	[e] 10.0	*R2*	2.25
		C3	8.00	*T3*	350	*P3*	287	*I3*	4.0	8.0	[e] 10.0	*R3*	2.10
Average			8.60		367		293		3.8		[e] 10.0		2.12
BJ				*T4*	425	*P4*	[f] 1,000	*I4*	10.0	6.5	[e] 10.0		
				T5	287	*P5*	[f] 1,000	*I5*	([d])	5.5	[e] 10.0		
				T6	350	*P6*	[f] 1,000	*I6*	([d])	5.0	[e] 10.0		
Average					354		[f] 1,000			5.7	[e] 10.0		
BK	50.5	*C1*	8.42	*T1*	276	*P1*	225	*I1*	3.5	6.0	[e] 10.0	*R1*	[f] 6.25
		C2	5.50	*T2*	348	*P2*	225	*I2*	3.5	6.0	[e] 10.0	*R2*	6.25
		C3	5.50	*T3*	310	*P3*	243	*I3*	2.5	7.5	[e] 10.0	*R3*	[f] 6.25
Average			6.47		311		231		3.2	6.5	[e] 10.0		
BK				*T4*	312	*P4*	[f] 1,000	*I4*	([d])	([d])	[f] 10.0		
				T5	294	*P5*	[f] 1,000	*I5*	([d])	([d])	[f] 10.0		
				T6	350	*P6*	[f] 1,000	*I6*	([d])	([d])	[f] 10.0		
Average					319		[f] 1,000		([d])	([d])	[f] 10.0		
BL	10.6	*C1*	6.19	*T1*	350	*P1*	347	*I1*	2.5	([d])	[e] 10.0	*R1*	1.70
		C2	9.12	*T2*	350	*P2*	300	*I2*	2.0	([d])	[e] 10.0	*R2*	1.63
		C3	7.12	*T3*	350	*P3*	250	*I3*	2.5	([d])	[e] 10.0	*R3*	1.59
Average			7.48		350		299		2.3	([d])	[e] 10.0		1.64
BL				*T4*	300	*P4*	785	*I4*	([d])	4.0	[e] 10.0		
				T5	258	*P5*	725	*I5*	([d])	4.5	[e] 10.0		
				T6	475	*P6*	750	*I6*	([d])	4.0	[e] 10.0		
Average					344		753		([d])	4.2	[e] 10.0		

[a] The compressive loads were applied one-third the thickness of the studs (1.21 in.) from the inside surface of the studs (see section III).
[b] Span 7 ft 6 in.
[c] A kip is 1,000 lb.
[d] Face did not fail.
[e] Test discontinued. Specimen damaged.
[f] Test discontinued. Specimen did not fail.

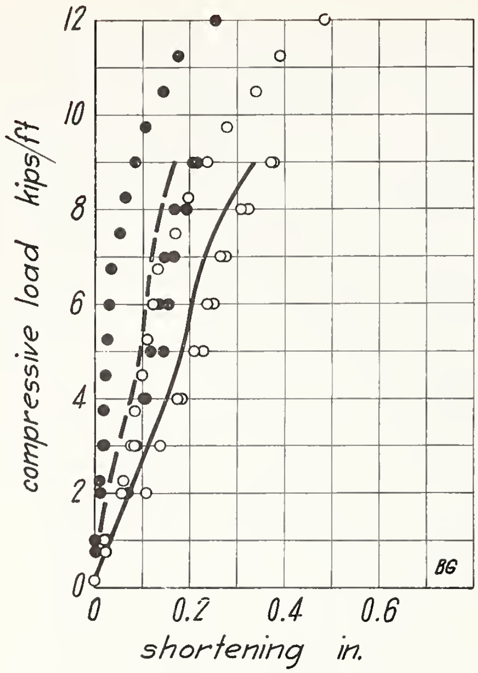

FIGURE 7.—*Compressive load on wall BG.*

Load-shortening (open circles) and load-set (solid circles) results for specimens *BG–C1*, *C2*, and *C3*. Load applied one-third the thickness (1.21 in.) from the inside surface of the studs. The loads are in kips per foot of actual width of specimen.

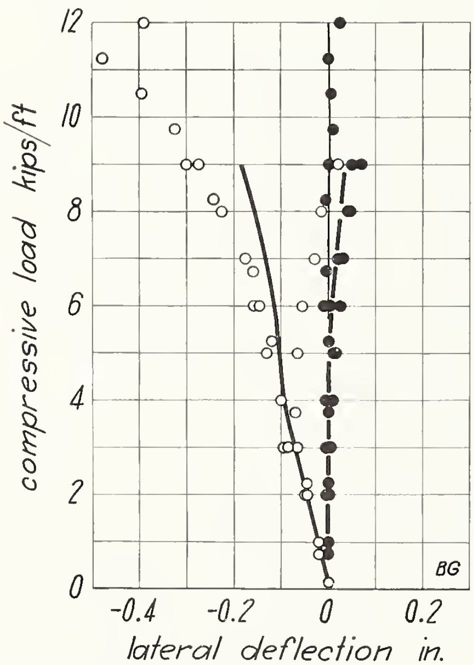

FIGURE 8.—*Compressive load on wall BG.*

Load-lateral deflection (open circles) and load-lateral set (solid circles) results for specimens *BG–C1*, *C2*, and *C3*. Load applied one-third the thickness (1.21 in.) from the inside surface of the studs. The loads are in kips per foot of actual width of specimen.

the maximum load the deflection of specimen *C1* was zero and the deflection of specimens *C2* and *C3* was toward the outside face. These deflections are not shown in figure 8. The change in the direction of the deflection curve probably indicates progressive local failure of the inside face.

Each of the specimens failed by crushing of the edges of the plaster at one or both ends of the specimen and local crushing of the lower member of the top plate at the inside edge of the studs. The top plate rotated and the specimens pushed out under load without breaking the studs.

3. Transverse Load

The results are shown in table 13 and in figure 9 for wall specimens *BG–T1*, *T2*, and *T3*, loaded on the inside face, and in figure 10 for wall specimens *BG–T4*, *T5*, and *T6*, loaded on the outside face.

In each of the specimens *T1*, *T2*, and *T3*, loaded on the inside (plastered) face, the plaster cracked longitudinally along each outer stud and transversely across the specimen in several

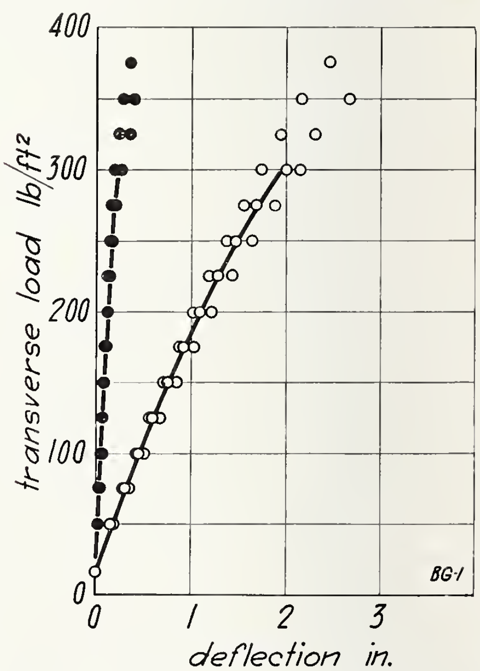

FIGURE 9. *Transverse load on wall BG, load applied to inside face.*

Load-deflection (open circles) and load-set (solid circles) results for specimens *BG–T1*, *T2*, and *T3* on the span 7 ft 6 in.

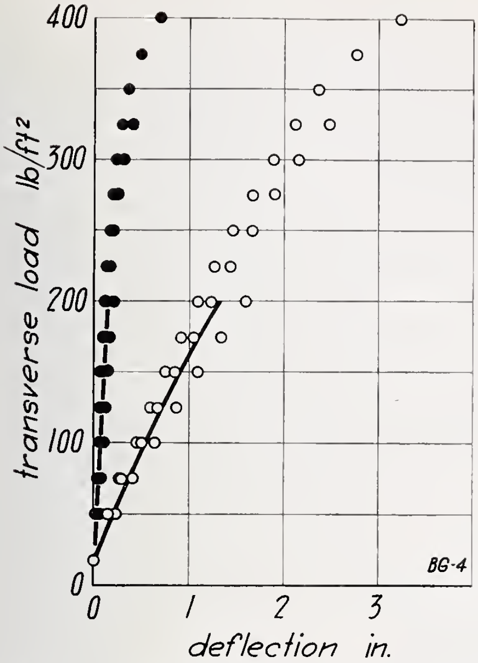

FIGURE 10.—*Transverse load on wall BG, load applied to outside face.*

Load-deflection (open circles) and load-set (solid circles) results for specimens *BG–T4, T5,* and *T6* on the span 7 ft 6 in.

places. The first longitudinal cracks occurred at loads of 225, 150, and 75 lb/ft² and deflections of 1.43, 0.75, and 0.28 in. in specimens *T1*, *T2*, and *T3*, respectively. The first transverse cracks occurred at lath joints near midspan and were observed after loads of 225, 225, and 275 lb/ft² and deflections of 1.43, 1.28, and 1.55 in. for specimens *T1*, *T2*, and *T3*, respectively. At the maximum load, specimen *T1* failed by rupture of one outer stud near a loading roller, rupture of the sheathing transversely across the specimen where the stud ruptured, and splitting of the siding on one edge at the same place. Specimen *T2* failed by rupture of all three studs near midspan, rupture of the sheathing, and splitting of two pieces of siding at the same place. Specimen *T3* failed by rupture of one outer stud near midspan, rupture of the sheathing, and splitting of the siding near the same place.

In each of the specimens *T4*, *T5*, and *T6*, loaded on the outside (bevel siding) face, the plaster cracked transversely across the specimen at several places and longitudinally over the studs at each end. In specimens *T4* and *T6* most of the transverse cracks were at lath joints, whereas in specimen *T5* most of the cracks were between lath joints. The first transverse cracks occurred near midspan at loads of 93, 75, and 87 lb/ft² and deflections of 0.44, 0.41, and 0.35 in. in specimens *T4*, *T5*, and *T6*, respectively. At the maximum load specimen *T4* failed by rupture of the center stud and one outer stud near a loading roller and separation of the siding from the sheathing between the loading rollers. Specimen *T5* failed by rupture of the center stud at midspan and one outer stud at a loading roller. Specimen *T6* failed by rupture of one outer stud between the loading rollers and rupture of the sheathing transversely across the specimen at a loading roller.

4. Concentrated Load

The results are shown in table 13 and in figure 11 for wall specimens *BG–P1*, *P2*, and

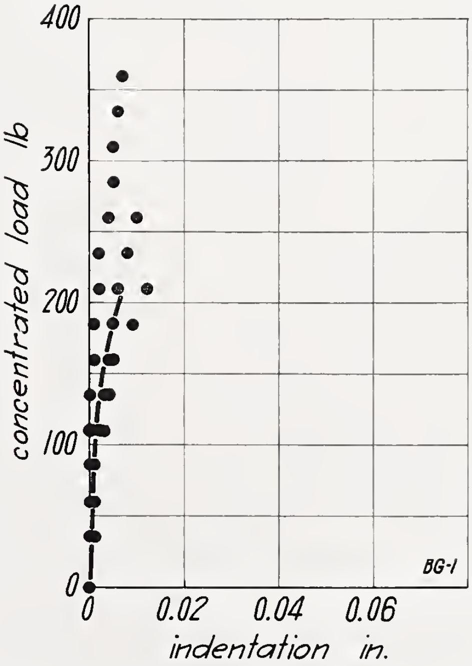

FIGURE 11.—*Concentrated load on wall BG, load applied to inside face.*

Load-indentation results for specimens *BG–P1, P2,* and *P3.*

P3, loaded on the inside face, and in figure 12 for wall specimens *BG–P4*, *P5*, and *P6*, loaded on the outside face.

The concentrated loads were applied to the inside face of specimens *P1*, *P2*, and *P3* on the plaster midway between two studs and about 1 ft 8 in. from the upper end of the specimen. On *P1* the load was applied over a lath joint. Each of the specimens failed by punching of the disk through the plaster and into the lath.

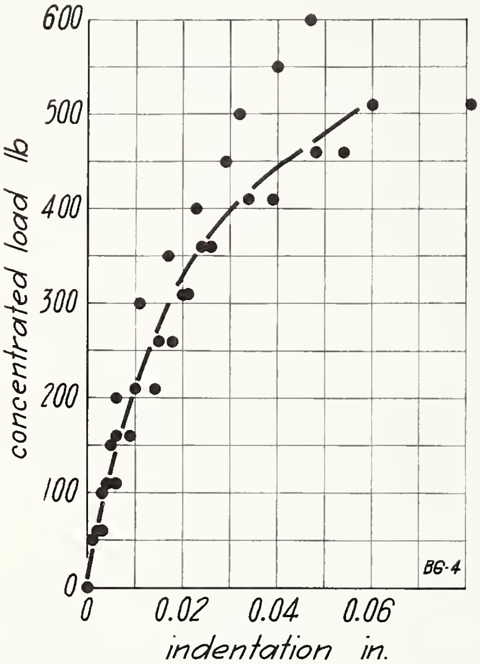

FIGURE 12.—*Concentrated load on wall BG, load applied to outside face.*

Load-indentation results for specimens *BG–P4*, *P5*, and *P6*.

The concentrated loads were applied to the outside face of specimens *P4*, *P5*, and *P6* on the wood bevel siding 3½, 2½, and 1½ in., respectively, from the edge of a strip of siding midway between two studs and about 2 ft 2 in. from the upper end of the specimen. In specimen *P4*, at a load of 435 lb, and in specimen *P5*, at a load of 210 lb, the siding split along the grain at one edge of the disk. At the maximum loads each of the specimens failed by splitting of the siding along the grain at opposite edges of the disk and rupture across the grain under the disk.

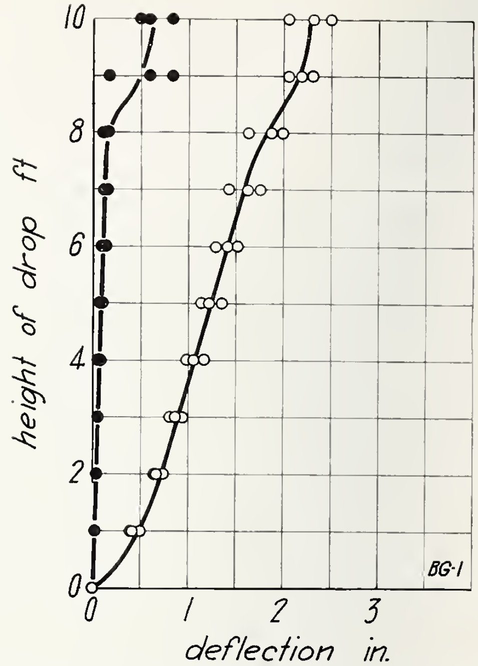

FIGURE 13.—*Impact load on wall BG, load applied to inside face.*

Height of drop-deflection (open circles) and height of drop-set (solid circles) results for specimens *BG–I1*, *I2*, and *I3* on the span 7 ft 6 in.

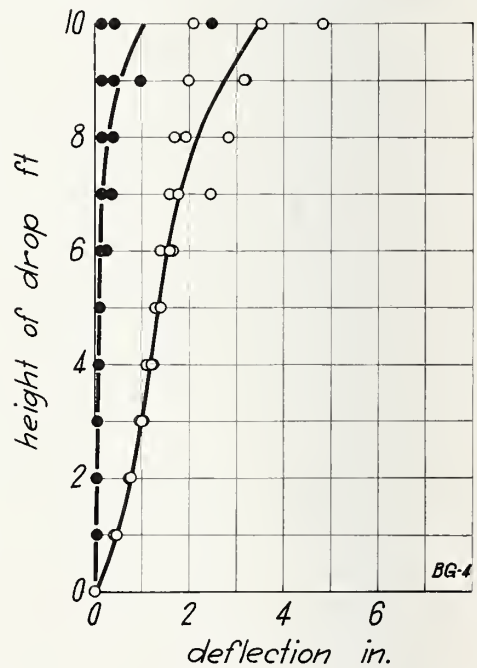

FIGURE 14.—*Impact load on wall BG, load applied to outside face.*

Height of drop-deflection (open circles) and height of drop-set (solid circles) results for specimens *BG–I4*, *I5*, and *I6* on the span 7 ft 6 in.

5. Impact Load

The results are shown in table 13 and in figure 13 for wall specimens *BG–I1*, *I2*, and *I3*, loaded on the inside face, and in figure 14 for wall specimens *BG–I4*, *I5*, and *I6*, loaded on the outside face.

The impact loads were applied to the center of the inside face of specimens *I1*, *I2*, and *I3*, the sandbag striking the plaster directly over the center stud. In each of the specimens *I1*, *I2*, and *I3* at drops of 1, 1.5, and 1.5 ft, and deflections of 0.50, 0.53, and 0.51 in., respectively, the plaster cracked longitudinally along the two outer studs. Also, in specimen *I1*, the plaster cracked longitudinally at the center stud where the sandbag struck. At drops of 1.5, 2.5, and 2.5 ft for specimens *I1*, *I2*, and *I3*, respectively, the inside face of each specimen failed by rupture of the plaster at the outer studs. After a drop of 10 ft the sets were 0.49, 0.83, and 0.59 in., respectively; the plaster and lath were broken where the sandbag struck, but the outside face and the studs did not fail.

The impact loads were applied to the center of the outside face of specimens *I4*, *I5*, and *I6*, the sandbag striking the bevel siding directly over the center stud. In each of the specimens *I4*, *I5*, and *I6* at drops of 2.5, 1, and 1 ft and deflections of 0.85, 0.50, and 0.49 in., respectively, the plaster cracked transversely across each specimen at a lath joint near midspan. At drops of 4, 3, and 3 ft for specimens *I4*,

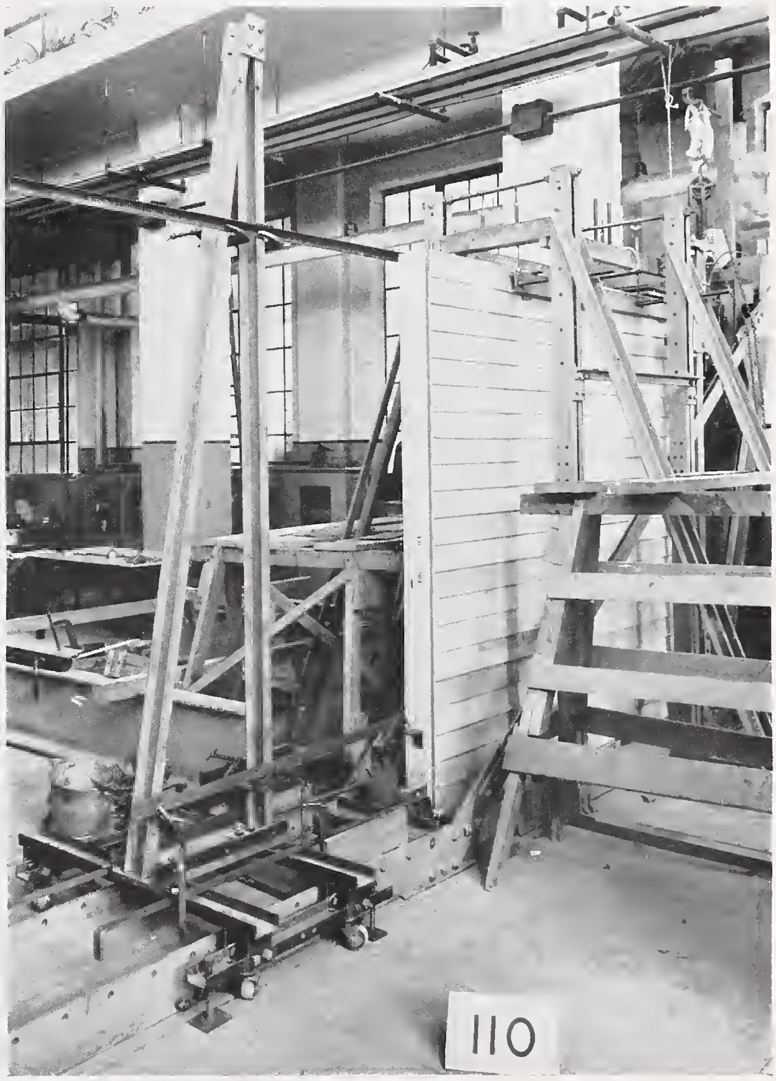

Figure 15.—*Wall specimen BG–R1, under racking load.*

I5, and *I6*, respectively, the inside face of each specimen failed by further cracking of the plaster. In specimen *I4* the set after a drop of 10 ft was 0.15 in.; several pieces of plaster and lath had fallen from one edge of the specimen, and the lath was separated from both outer studs at midspan, but the outside face and the studs did not fail. In specimen *I5* the center stud broke about 2 ft from midspan at a drop of 6 ft. The set after a drop of 10 ft was 0.41 in.; several pieces of plaster and one section of lath had fallen from the center of the specimen, but the outside face did not fail. In specimen *I6* the center stud broke at midspan at a drop of 8.5 ft, one outer stud broke at midspan at a drop of 9 ft, and the outside face failed at a drop of 9.5 ft by splitting of the siding at midspan. The set after a drop of 10 ft was 2.49 in.; several pieces of plaster and one course of lath had fallen, and the sheathing was ruptured at the center of the specimen.

6. Racking Load

Wall specimen *BG–R1* under racking load is shown in figure 15. The results for wall

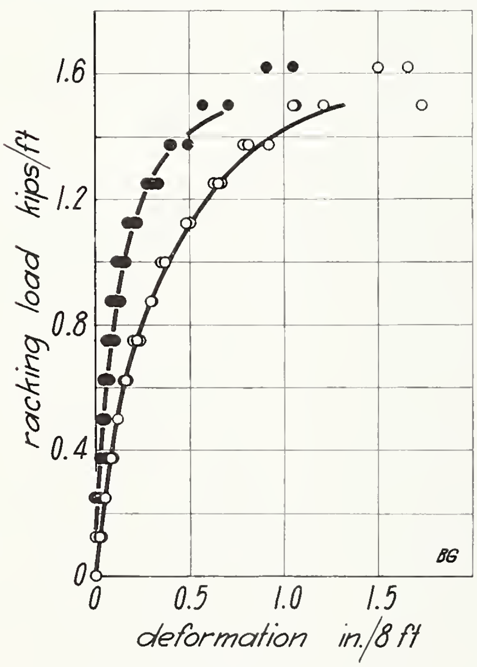

Figure 16.—*Racking load on wall BG.*

Load-deformation (open circles) and load-set (solid circles) results for specimens *BG–R1*, *R2*, and *R3*. The loads are in kips per foot of the face width of specimen (8 ft 0 in.).

specimens *BG–R1*, *R2*, and *R3* are shown in table 13 and in figure 16.

The racking loads were applied to the top plate only, and the stop at the diagonally opposite corner of the specimen was in contact with the floor plate only. In each of the specimens the plaster cracked in several places. Most of the cracks were parallel to a diagonal from the point of application of load to the stop. The first significant cracks occurred at loads of 1.125, 1.285, and 1.500 kips/ft and deformations of 0.48, 0.72, and 1.21 in./8 ft in specimens *R1*, *R2*, and *R3*, respectively. At the maximum loads each of the specimens failed by shearing of the plaster from the lath, pulling of some of the nails through the edge of the sheathing, and displacement of the top plate horizontally with respect to the studs—the nails pulling from the studs.

VI. WALL *BH*

1. Description, Sponsor's Statement

This construction was a wood frame with "Bildrite" sheathing and wood bevel siding on the outside face and ¾-in. "Graylite" interior board on the inside face. It was similar to construction *BG*, with the exception that the inside face was interior board, not lath and plaster.

The price in Washington, D. C., as of July 1937, was $0.28/ft².

(*a*) *Four-Foot Wall Specimens*

The 4-ft wall specimens were 8 ft 0 in. high, 4 ft 0 in. wide, and 5⅝ in. thick. Each specimen consisted of a wood frame to which the faces were fastened. The frame consisted of three studs, *A*, shown in figure 17, fastened to a floor plate, *B*, and a top plate, *C*, by nails. The outside face consisted of insulating-board sheathing, *D*, and wood bevel siding, *E*. The inside face was interior board, *F*, with a vertical joint at midwidth covered by a batten strip, *G*. The specimens were not painted.

Studs.—The studs, *A*, were red pine, 1⅝ by 3⅝ in. (nominal 2 by 4 in), 7 ft 7⅛ in. long, spaced 1 ft 4 in. on centers. The lower end of each stud was fastened to the floor plate by two 16d common nails driven from the bottom of the plate (not toenailed), and the upper end of each stud was fastened to the top plate by two 16d common nails driven from the top of the lower member of the plate.

Floor plate.—The floor plate, *B*, was red pine, 1⅝ by 3⅝ in. (nominal 2 by 4 in), 4 ft 0 in. long.

Top plate.—The top plate, *C*, consisted of two pieces of red pine, 1⅝ by 3⅝ in. (nominal 2 by 4 in), 4 ft 0 in. long, fastened by ten 10d common nails driven from the top of the lower member of the plate.

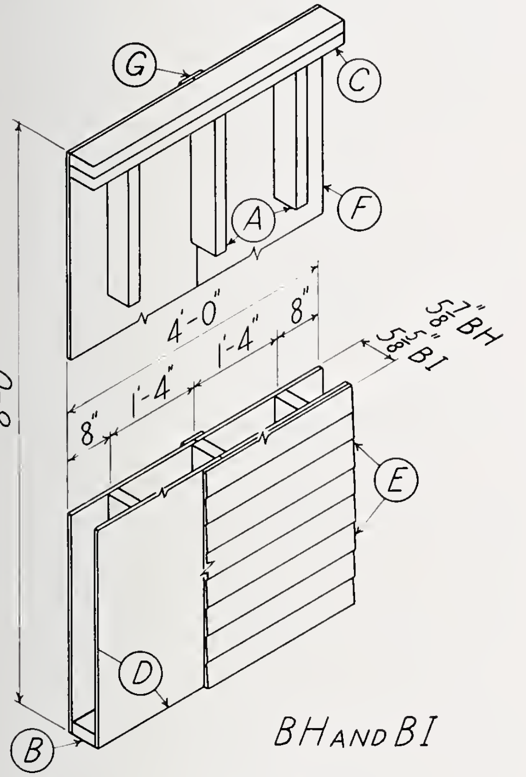

FIGURE 17.—*Four-foot wall specimens BH and BI.*

A, stud; *B*, floor plate; *C*, top plate; *D*, sheathing; *E*, bevel siding; *F*, interior board; *G*, batten strip.

Sheathing.—The sheathing, *D*, was two "Bildrite" sheathing boards, 25/32 in. by 1 ft 11 15/16 in., 8 ft 0 in. long, with the linen-textured surface outward. There was a vertical joint on the center stud with ⅛-in. clearance between the edges of the boards. The boards were fastened to the center stud, floor plate, and top plate by 8d common nails spaced 3 in., about ½ in. from the edges of the boards, and to the two outer studs by 8d common nails spaced 6 in.

Bevel siding.—The bevel siding, *E*, was 21 pieces of northern white pine, 7/16 by 3/16 by 5½ in., 4 ft 0 in. long, exposed 4½ in. to the weather, and fastened through the overlapping edges by 10d box nails, one at each stud.

Interior board.—The interior board, *F*, was two "Graylite" interior boards, ¾ in. by 1 ft 11 15/16 in., 8 ft 0 in. long, with the linen-textured surface exposed. There was a vertical joint on the center stud with ⅛-in. clearance between the edges of the boards. The boards were fastened to the center stud, floor plate, and top plate by 8d common nails spaced 3 in., about ½ in. from the edges of the boards, and to the two outer studs by 6d finishing nails spaced 6 in., driven at an angle, adjacent nails being inclined in opposite directions.

Batten strip.—The batten strip, *G*, was "Graylite" interior board, ½ by 2½ in., 8 ft 0 in. long, with beveled outer edges. The batten strip covered the vertical joint at midwidth and was fastened to the center stud by two rows of 6d finishing nails spaced 3 in., driven through the beveled edges, through the interior board, and into the center stud.

(*b*) *Eight-Foot Wall Specimens*

The 8-ft wall specimens were 8 ft 0 in. high, 8 ft 0 in. face width, and 5⅞ in. thick. The specimens were similar to the 4-ft specimens, with the exception that there were seven studs spaced 1 ft 4 in. on centers. There was a stud at each edge extending one-half its thickness beyond the faces, over-all width 8 ft 1⅝ in. The two members of the top plate were fastened by twenty 10d common nails.

Sheathing and interior board.—The sheathing and the interior board each consisted of two boards, 3 ft 11⅞ in. wide, having a vertical joint on the center stud, with ⅛-in. clearance between the edges of the boards. The sheathing boards were fastened to the edge studs, center stud, floor plate, and top plate by 8d common nails spaced 3 in., about ½ in. from the edges of the boards, and to the other four studs by 8d common nails spaced 6 in. The interior boards were fastened to the edge studs, center stud, floor plate, and top plate by 8d common nails spaced 3 in., about ½ in. from the edges of the boards, and to the other four studs by 6d finishing nails spaced 6 in., driven at an angle, adjacent nails being inclined in opposite directions. The batten strip was similar to that on the 4-ft specimen.

2. Compressive Load

The results for wall specimens *BH–C2* and *C3* are shown in table 13 and in figures 18 and 19. The results for specimen *C1* are not reported because the compressometers were attached to the studs and did not measure the local crushing of the floor plate and the top plate. The maximum load for this specimen is not given in table 13 because the clearance for eccentric loading was not sufficient and the loading plates came into contact with the platen of the testing machine before the maximum load could be definitely ascertained. With the loading plate in contact with the platen, the load was increased to a maximum of 11.0 kips/ft. At this load one outer stud broke at midheight.

The lateral deflections shown in figure 19 were plotted to the right of the vertical axis for

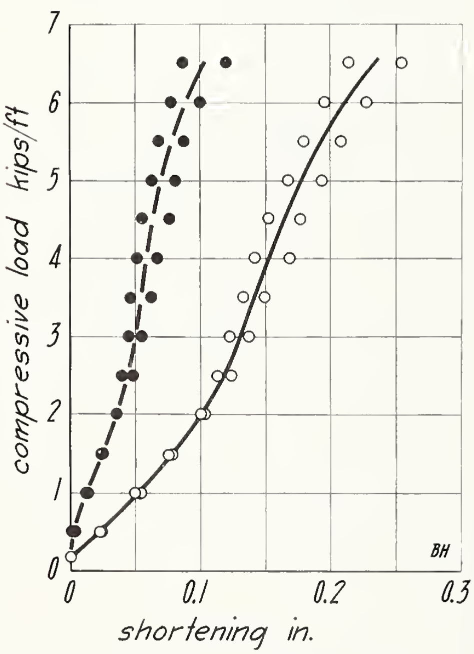

Figure 18.—*Compressive load on wall BH.*

Load-shortening (open circles) and load-set (solid circles) results for specimens *BH–C2* and *C3*. Load applied one-third the thickness (1.21 in.) from the inside surface of the studs. The loads are in kips per foot of actual width of specimen.

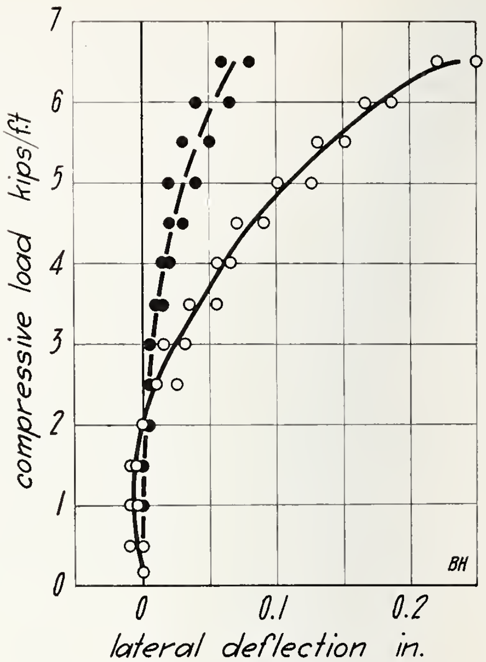

Figure 19.—*Compressive load on wall BH.*

Load-lateral deflection (open circles) and load-lateral set (solid circles) results for specimens *BH–C2* and *C3*. Load applied one-third the thickness (1.21 in.) from the inside surface of the studs. The loads are in kips per foot of actual width of specimen.

deflections of the specimens toward the outside face and to the left for deflections toward the inside face. No explanation was found for the deflection of the specimens toward the inside face under loads less than 2 kips/ft.

In specimen *C2* at a load of 5 kips/ft the interior board started to separate from the two outer studs. In specimen *C3* at a load of 3 kips/ft the interior board started to separate from one end of the top plate. At the maximum load on each specimen the top plate crushed locally at the inside edge of the studs and separated at the outside edge. This rotation of the plate pulled the nails from the studs, ruptured the sheathing transversely across the specimen just below the plate, and allowed the specimens to push out under load without breaking the studs.

3. Transverse Load

The results are shown in table 13 and in figure 20 for wall specimens *BH–T1*, *T2*, and *T3*, loaded on the inside face, and in figure 21 for wall specimens *BH–T4*, *T5*, and *T6*, loaded on the outside face.

In each of the specimens *T1*, *T2*, and *T3* the interior board started to separate from the studs near one or both ends at loads of 240, 150, and 150 lb/ft^2 and deflections of 1.57, 0.82, and 0.90 in., respectively. At the maximum load specimen *T1* failed by rupture of all three studs and the sheathing at a loading roller. Specimens *T2* and *T3* failed by rupture of the center stud, one outer stud, and also the sheathing at a loading roller.

Specimen *T4* failed by rupture of one outer stud and the interior board under a loading roller. Specimens *T5* and *T6* failed by rupture of the center stud, one outer stud, and also the interior board at a loading roller.

4. Concentrated Load

Wall specimen *BH–P4* under concentrated load is shown in figure 22. The results are shown in table 13 and in figure 23 for wall specimens *BH–P1*, *P2*, and *P3*, loaded on the inside face, and in figure 24 for wall specimens *BH–P4*, *P5*, and *P6*, loaded on the outside face.

The concentrated loads were applied to the inside face of specimens *P1*, *P2*, and *P3*, on the interior board midway between two studs and 3 to 4 ft from one end. Each of the specimens *P1*, *P2*, and *P3* failed by punching of the disk through the interior board.

The concentrated loads were applied to the outside face of specimens *P4*, *P5*, and *P6* on the bevel siding 1½ in. from the edge of a strip of siding midway between two studs and 3 to 3½ ft from one end. Each of the specimens failed by splitting of the siding for about 6 in. along the grain on opposite edges of the disk.

5. Impact Load

The results are shown in table 13 and in figure 25 for wall specimens *BH–I1*, *I2*, and *I3*, loaded on the inside face, and in figure 26 for wall specimens *BH–I4*, *I5*, and *I6*, loaded on the outside face.

The impact loads were applied to the center of the inside face of specimens *I1*, *I2*, and *I3*, the sandbag striking the batten strip and interior board directly over the center stud. In specimen *I1* the center stud broke at midspan at a drop of 9.5 ft. The set after a drop of 10 ft was 0.49 in., the interior board was dented

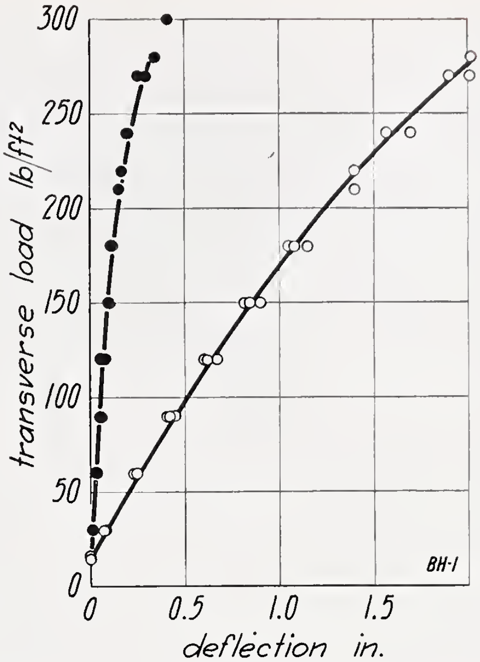

FIGURE 20.—*Transverse load on wall BH, load applied to inside face.*

Load-deflection (open circles) and load-set (solid circles) results for specimens *BH–T1*, *T2*, and *T3* on the span 7 ft 6 in.

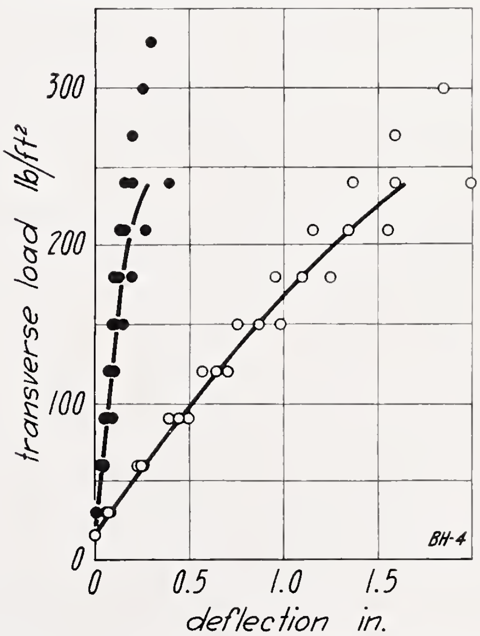

FIGURE 21.—*Transverse load on wall BH, load applied to outside face.*

Load-deflection (open circles) and load-set (solid circles) results for specimens *BH–T4*, *T5*, and *T6* on the span 7 ft 6 in.

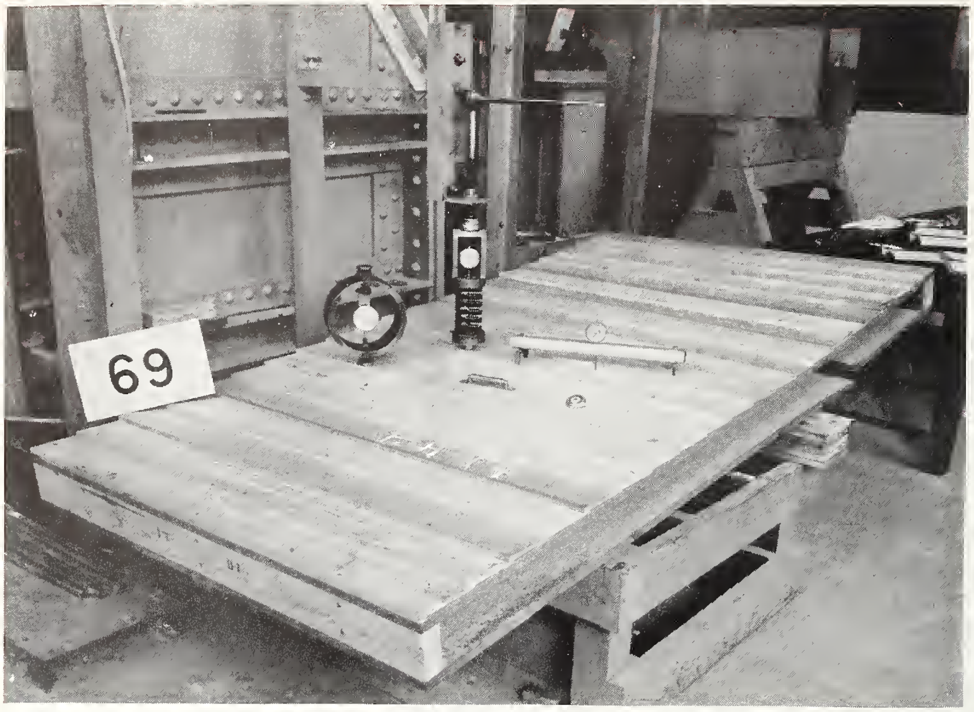

Figure 22.—*Wall specimen BH–P4 under concentrated load.*

This specimen was an undamaged portion of specimen *BH–T4*.

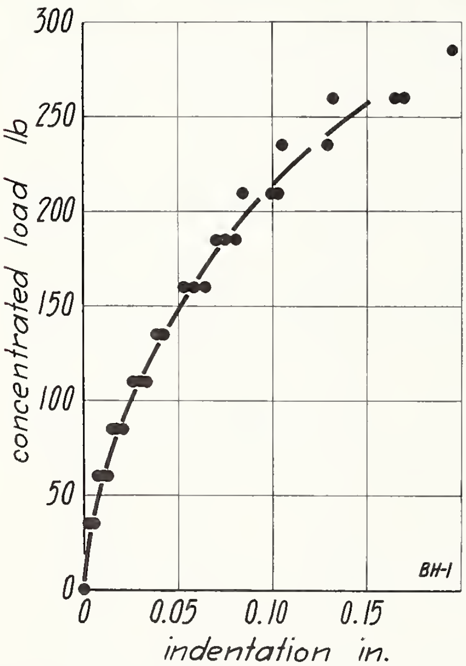

Figure 23.—*Concentrated load on wall BH, load applied to inside face.*

Load-indentation results for specimens *BH–P1*, *P2*, and *P3*.

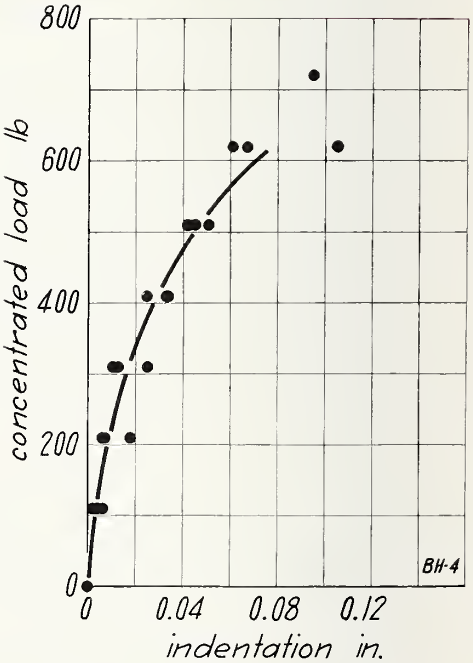

Figure 24.—*Concentrated load on wall BH, load applied to outside face.*

Load-indentation results for specimens *BH–P4*, *P5*, and *P6*.

where the edge of the sandbag struck, and the sheathing on the opposite face was ruptured transversely across the specimen at midspan. In specimen *I2* the inside face failed at a drop of 9.5 ft by rupture of the interior board where the edge of the sandbag struck. The set after a drop of 10 ft was 0.16 in.; the studs and outside face were undamaged. In specimen *I3* the center stud broke at midspan at a drop of 5.5 ft. At a drop of 7.5 ft one outer stud broke at midspan and the outside face failed by splitting of the siding and rupture of the sheathing transversely across the specimen at midspan. The set after a drop of 10 ft was 1.95 in., and the interior board was cracked but not ruptured where the edge of the sandbag struck.

The impact loads were applied to the center of the outside face of specimens *I4*, *I5*, and *I6*, the sandbag striking the bevel siding directly over the center stud. At drops of 6, 6, and 5 ft for specimens *I4*, *I5*, and *I6*, respectively, the interior board of each specimen started to separate from the outer studs at midspan. In each of the specimens *I4* and *I6* the center stud broke at midspan and the inside face failed by rupture of the interior board transversely across the specimen at midspan at a drop of 7 ft. The sets after a drop of 10 ft were 0.50 and 0.60 in. in specimens *I4* and *I6*, respectively, the interior board was separated from the studs, and the siding was split where the sandbag struck, but the outside face did not fail. In specimen *I5* the set after a drop of 10 ft was 0.20 in.; the interior board was separated from the studs but not broken, and the studs and outside face were undamaged.

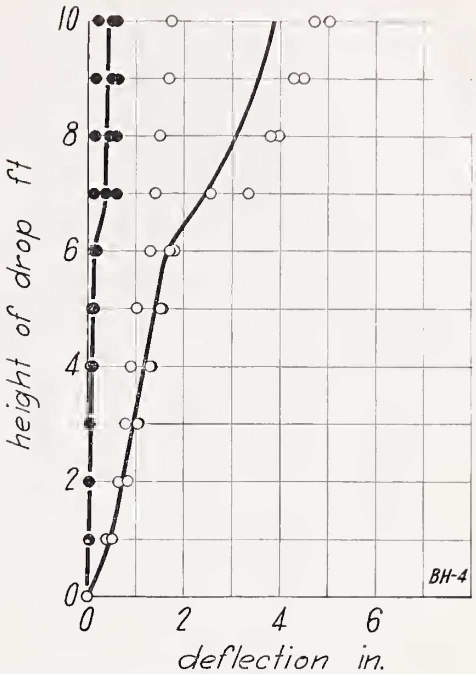

Figure 26.—*Impact load on wall BH, load applied to outside face.*

Height of drop-deflection (open circles) and height of drop-set (solid circles) results for specimens *BH–I4*, *I5*, and *I6* on the span 7 ft 6 in.

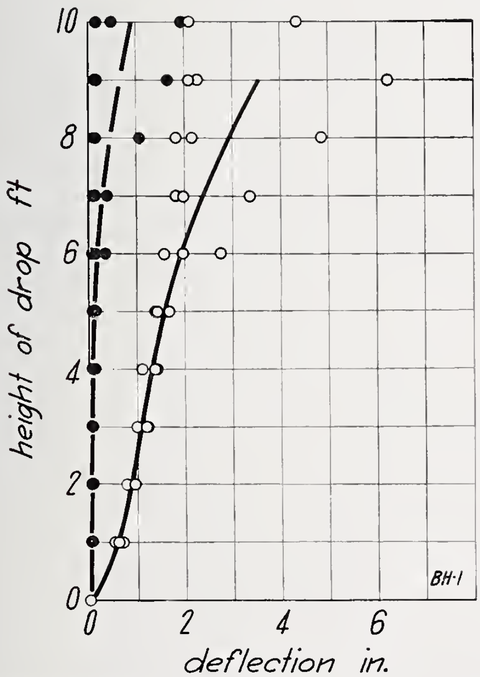

Figure 25.—*Impact load on wall BH, load applied to inside face.*

Height of drop-deflection (open circles) and height of drop-set (solid circles) results for specimens *BH–I1*, *I2*, and *I3* on the span 7 ft 6 in.

6. Racking Load

The results for wall specimens *BH–R1*, *R2*, and *R3* are shown in table 13 and in figure 27.

The racking loads were applied to the top plate only, and the stop was in contact with the floor plate only. At loads of 1.625, 1.726 (maximum load), and 1.375 kips/ft there was noticeable vertical displacement between the two sheathing boards at the joint. At the maximum load each of the specimens failed by the top plate pulling the nails from the studs and through the edges of the sheathing and interior board.

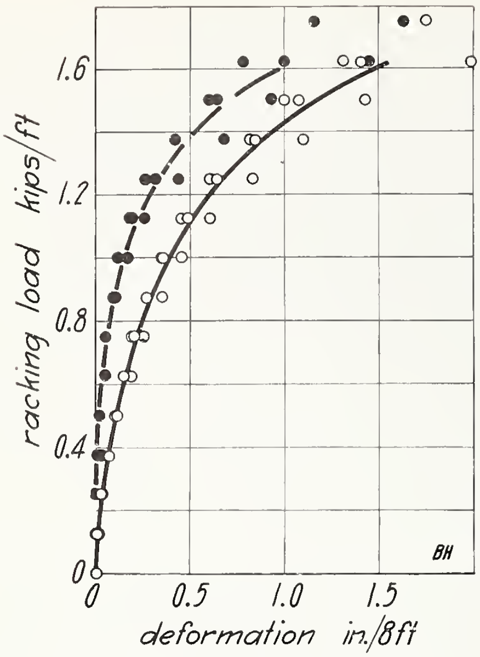

FIGURE 27.—*Racking load on wall BH.*

Load-deformation (open circles) and load-set (solid circles) results for specimens *BH-R1, R2*, and *R3*. The loads are in kips per foot of the face width of specimen (8 ft 0 in.).

VII. WALL *BI*

1. Description, Sponsor's Statement

This construction was a wood frame with "Bildrite" sheathing and wood bevel siding on the outside face and ½-in. "Graylite" interior board on the inside face. It was similar to construction *BG*, with the exception that the inside face was interior board, not lath and plaster. It was similar to construction *BH*, with the exception that the interior board was ½ in. thick, not ¾ in.

The price in Washington, D. C., as of July 1937, was $0.26/ft².

(*a*) *Four-Foot Wall Specimens*

The 4-ft wall specimens were 8 ft 0 in. high, 4 ft 0 in. wide, and 5⅝ in. thick. Each specimen consisted of a wood frame to which the faces were fastened. The frame consisted of three studs, *A*, shown in figure 17, fastened to a floor plate, *B*, and a top plate, *C*, by nails. The outside face consisted of insulating-board sheathing, *D*, and wood bevel siding, *E*. The inside face was interior board, *F*, with a vertical joint at midwidth covered by a batten strip, *G*. The specimens were not painted.

Studs.—The studs, *A*, were red pine, 1⅝ by 3⅝ in. (nominal 2 by 4 in.), 7 ft 7⅛ in. long, spaced 1 ft 4 in. on centers. The lower end of each stud was fastened to the floor plate by two 16d common nails driven from the bottom of the floor plate (not toenailed), and the upper end of each stud was fastened to the top plate by two 16d common nails driven from the top of the lower member of the plate.

Floor plate.—The floor plate, *B*, was red pine, 1⅝ by 3⅝ in. (nominal 2 by 4 in.), 4 ft 0 in. long.

Top plate.—The top plate, *C*, consisted of two pieces of red pine, 1⅝ by 3⅝ in. (nominal 2 by 4 in), 4 ft 0 in. long, fastened by ten 10d common nails driven from the top of the plate.

Sheathing.—The sheathing, *D*, was two "Bildrite" sheathing boards, 25/32 in. by 1 ft 11 15/16 in., 8 ft 0 in. long, with the linen-textured surface outward. There was a vertical joint on the center stud, with ⅛-in. clearance between the edges of the boards. The boards were fastened to the center stud, floor plate, and top plate by 8d common nails spaced 3 in., about ½ in. from the edges of the boards, and to the two outer studs by 8d common nails spaced 6 in.

Bevel siding.—The bevel siding, *E*, was 21 pieces of northern white pine, 7/16 by 3/16 by 5½ in., 4 ft 0 in. long, exposed 4½ in. to the weather, and fastened through the overlapping edges by 10d box nails, one at each stud.

Interior board.—The interior board, *F*, was two "Graylite" building boards, ½ in. by 1 ft 11 15/16 in., 8 ft 0 in. long, with the linen-textured surface exposed. There was a vertical joint on the center stud with ⅛-in. clearance between the edges of the boards. The boards were fastened to the center stud, floor plate, and top plate by 4d galvanized roofing nails spaced 3 in., about ½ in. from the edges of the boards, and to the outer studs by 4d finishing nails spaced 6 in., driven at an angle, adjacent nails being inclined in opposite directions.

Batten strip.—The batten strip, *G*, was "Graylite" building board, ½ by 2½ in., 8 ft 0 in. long, with beveled outer edges. The batten strip covered the vertical joint at midwidth and was fastened to the center stud by two rows of 4d finishing nails spaced 3 in., driven through the beveled edges, through the interior board, and into the center stud.

(*b*) *Eight-Foot Wall Specimens*

The 8-ft wall specimens were 8 ft 0 in. high, 8 ft 0 in. face width, and 5⅝ in. thick. The specimens were similar to the 4-ft specimens, with the exception that there were seven studs, spaced 1 ft 4 in. on centers. There was a stud at each edge extending one-half its thickness beyond the faces; over-all width 8 ft 1⅝ in. The two members of the top plate were fastened by twenty 10d common nails.

Sheathing and interior board.—The sheathing and interior board each consisted of two boards, 3 ft 11⅞ in. wide. There was a vertical joint on the center stud, with ⅛-in. clearance between the edges of the boards. The sheathing boards were fastened to the edge studs, center stud, floor plate, and top plate by 8d common nails spaced 3 in., about ½ in. from the edges of the boards, and to the other four studs by 8d common nails spaced 6 in.

The interior boards were fastened to the edge studs, center stud, floor plate, and top plate by 4d galvanized roofing nails spaced 3 in., about ½ in. from the edges of the boards, and to the other four studs by 4d finishing nails spaced 6 in. driven at an angle, adjacent nails being inclined in opposite directions. The batten strip was the same as that on the 4-ft specimen.

2. Compressive Load

The results for wall specimens *BI–C1*, *C2*, and *C3* are shown in table 13 and in figures 28 and 29.

The lateral deflections shown in figure 29 are plotted to the right of the vertical axis for deflections of the specimens toward the outside face and to the left for deflections toward the inside face. No explanation was found for the deflection of the specimens toward the inside face under loads less than 4 kips/ft.

At loads of 3.5 and 2.5 kips/ft on specimens *C1* and *C2*, respectively, the interior board started to separate from the upper end of one

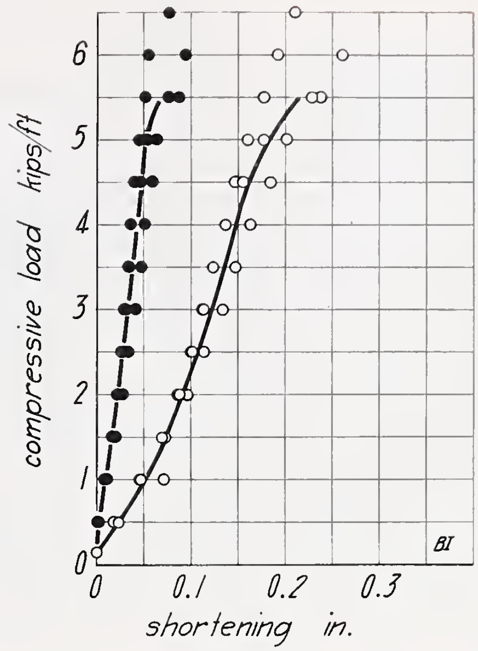

Figure 28.—*Compressive load on wall BI.*

Load-shortening (open circles) and load-set (solid circles) results for specimens *BI-C1*, *C2*, and *C3*. Load applied one-third the thickness (1.21 in.) from the inside surface of the studs. The loads are in kips per foot of actual width of specimen.

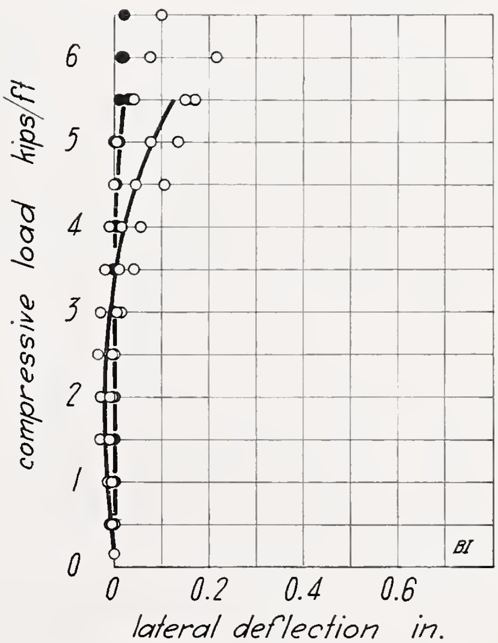

Figure 29.—*Compressive load on wall BI.*

Load-lateral deflection (open circles) and load-lateral set (solid circles) results for specimens *BI-C1*, *C2*, and *C3*. Load applied one-third the thickness (1.21 in.) from the inside surface of the studs. The loads are in kips per foot of actual width of specimen.

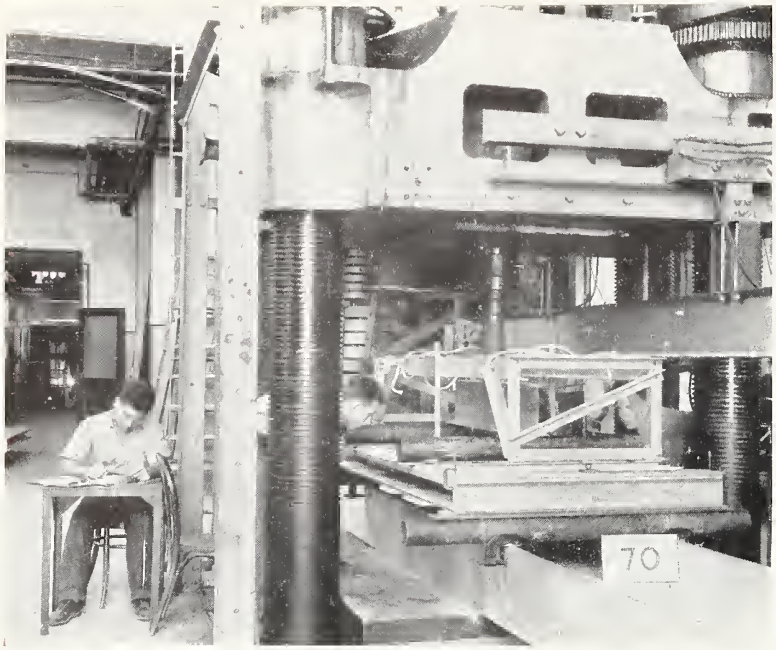

Figure 30.—*Wall specimen BI–T6 under transverse load.*

of the outer studs. At loads of 5, 4.25, and 4.5 kips/ft for specimens *C1*, *C2*, and *C3*, respectively, the heads of some of the nails fastening the interior board to the outer studs pulled through the board and the board bowed away from the studs from midheight to the upper end. At the maximum load on each specimen the top plate crushed locally at the inside edge of the studs and separated at the outside edge. This rotation of the top plate pulled the nails from the studs, ruptured the sheathing transversely across the specimen just below the plate, and allowed the specimen to push out under load without breaking the studs.

3. Transverse Load

Wall specimen *BI–T6* under transverse load is shown in figure 30. The results are shown in table 13 and in figure 31 for wall specimens *BI–T1*, *T2*, and *T3*, loaded on the inside face, and in figure 32 for wall specimens *BI–T4*, *T5*, and *T6*, loaded on the outside face.

Specimen *T1* failed by rupture of the center stud and one outer stud at a loading roller and rupture of both the interior board and the sheathing halfway across the specimen at the same place. Specimen *T2* failed by rupture of all three studs under a loading roller and rupture of the sheathing and siding at the same place. Specimen *T3* failed by rupture of the center stud and one outer stud at a loading roller and rupture of the sheathing and siding transversely across the specimen at the same place.

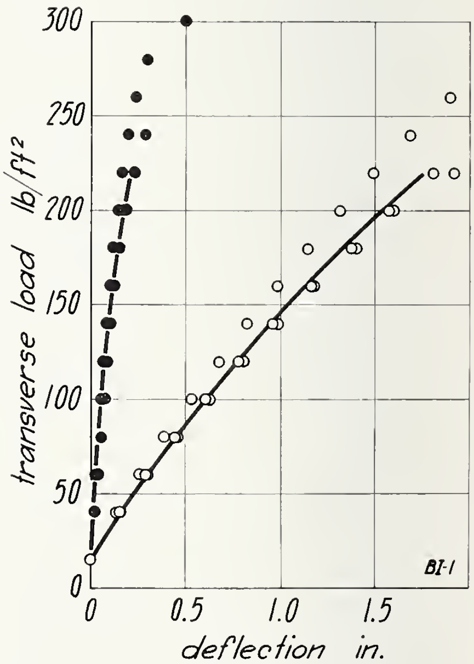

Figure 31.—*Transverse load on wall BI, load applied to inside face.*

Load-deflection (open circles) and load-set (solid circles) results for specimens *BI–T1*, *T2*, and *T3* on the span 7 ft 6 in.

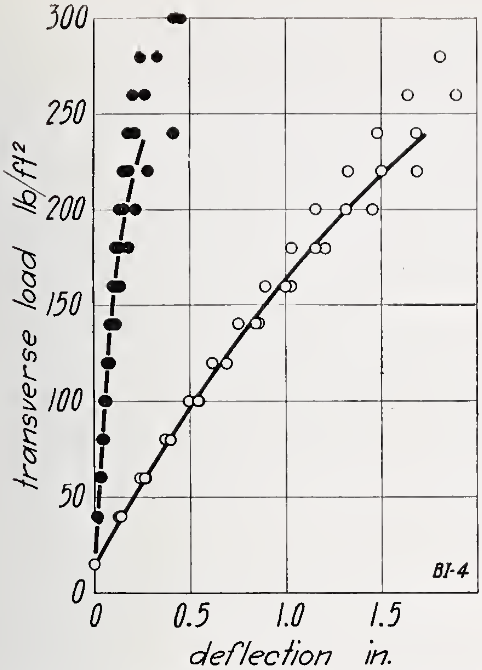

FIGURE 32.—*Transverse load on wall BI, load applied to outside face.*

Load-deflection (open circles) and load-set (solid circles) results for specimens *BI–T4*, *T5*, and *T6* on the span 7 ft 6 in.

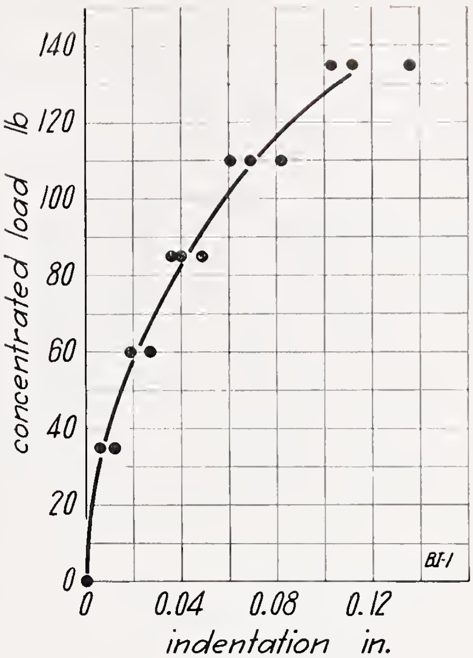

FIGURE 33.—*Concentrated load on wall BI, load applied to inside face.*

Load-indentation results for specimens *BI–P1*, *P2*, and *P3*.

Specimens *T4* and *T5* failed by rupture of the center stud, one outer stud, and the interior board between the loading rollers. Specimen *T6* failed by rupture of one outer stud at midspan, splitting of the center stud along the grain from midspan to the top plate, and rupture of the interior board at midspan.

4. Concentrated Load

The results are shown in table 13 and in figure 33 for wall specimens *BI–P1*, *P2*, and *P3*, loaded on the inside face, and in figure 34 for wall specimens *BI–P4*, *P5*, and *P6*, loaded on the outside face.

The concentrated loads were applied to the inside face of specimens *P1*, *P2*, and *P3* on the interior board midway between two studs and 3 to 3½ ft from one end. Each of the specimens failed by punching of the disk through the interior board.

The concentrated loads were applied to the outside face of specimens *P4*, *P5*, and *P6* on the bevel siding 1½ in. from the edge of a strip of siding midway between two studs and 2½ to

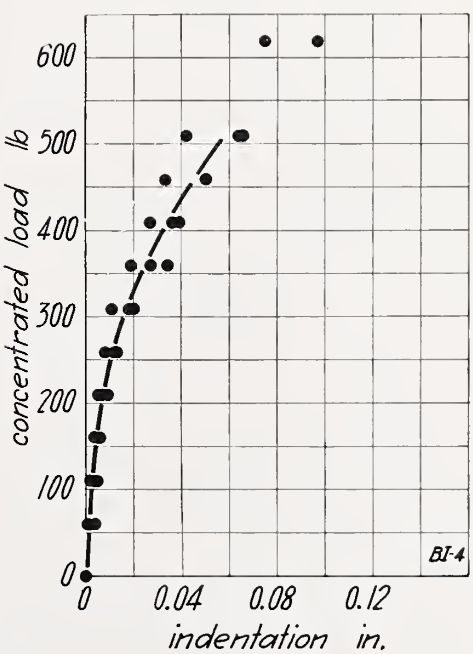

FIGURE 34.—*Concentrated load on wall BI, load applied to outside face.*

Load-indentation results for specimens *BI–P4*, *P5*, and *P6*.

3½ ft from one end. Each of the specimens failed by splitting of the siding for about 8 in. along the grain on opposite edges of the disk.

5. Impact Load

The results are shown in table 13 and in figure 35 for wall specimens *BI–I1*, *I2*, and *I3*, loaded on the inside face, and in figure 36 for wall specimens *BI–I4*, *I5*, and *I6*, loaded on the outside face.

The impact loads were applied to the center of the inside face of specimens *I1*, *I2*, and *I3*, the sandbag striking the batten strip and interior board directly over the center stud.

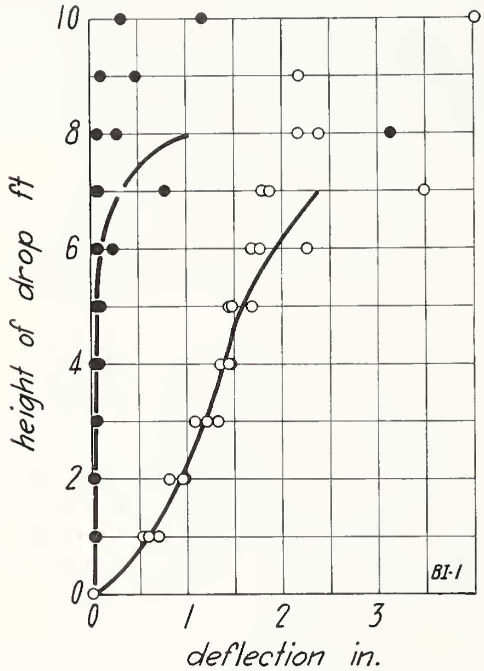

Figure 35.—*Impact load on wall BI, load applied to inside face.*

Height of drop-deflection (open circles) and height of drop-set (solid circles) results for specimens *BI–I1*, *I2*, and *I3* on the span 7 ft 6 in.

In specimen *I1* at a drop of 5.5 ft the interior board separated from the outer studs at midspan; at 8.5 ft the siding on the opposite face cracked at midspan; at 9 ft both faces failed, the inside face by rupture of the interior board where the sandbag struck, the outside face by cracking of both the siding and sheathing at midspan. At 9.5 ft one outer stud broke at midspan. At 10 ft the set was 1.19 in. and the center stud was broken. In specimen *I2* at a drop of 5.5 ft the interior board started to separate from the studs at midspan; at 7 ft one outer stud broke and both faces failed, the inside face by breaking of the interior board where the sandbag struck, the outside face by rupture of the sheathing. At 7.5 ft all three studs were broken, and at 9 ft the specimen broke in two pieces at midspan. In specimen *I3* at a drop of 6.5 ft the interior board separated from the outer studs near midspan, and at 9 ft the interior board cracked where the edge of the sandbag struck. At 10 ft the inside face failed by rupture of the interior board where the sandbag struck; the center stud broke at midspan, but the outside face did not fail.

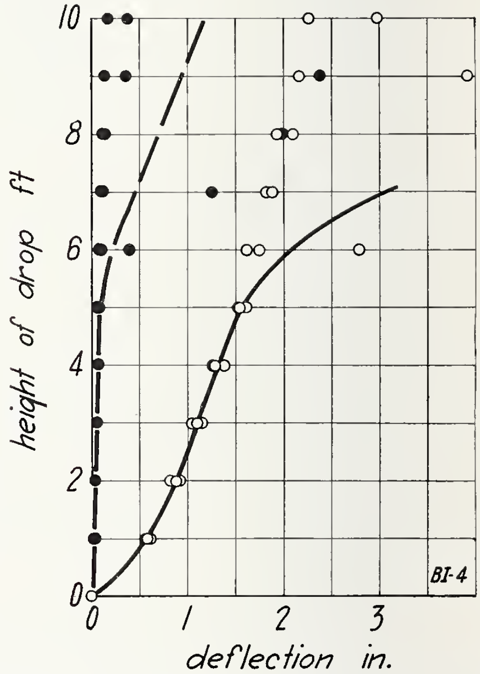

Figure 36.—*Impact load on wall BI, load applied to outside face.*

Height of drop-deflection (open circles) and height of drop-set (solid circles) results for specimens *BI–I4*, *I5*, and *I6* on the span 7 ft 6 in.

The impact loads were applied to the center of the outside face of specimens *I4*, *I5*, and *I6*, the sandbag striking the wood bevel siding directly over the center stud. In specimen *I4* at a drop of 4 ft the interior board on the opposite face separated from the studs at midspan, at 5.5 ft the center stud broke at midspan, and at 6 ft the inside face failed by rupture of the interior board transversely across the specimen. At 6.5 ft one outer stud broke at midspan and at 7 ft the outside face failed by opening of the siding at midspan. After a drop of 10 ft the set was 2.98 in., three siding strips were cracked, and the sheathing was ruptured halfway across the specimen. In specimen *I5* at a drop of 3 ft the interior board separated from one outer stud at midspan and at 9.5 ft the siding cracked where the sandbag struck. After a drop of 10 ft the set was 0.16 in. and neither the faces nor the studs had failed. In specimen *I6* at a drop of 2.5 ft the interior board separated from the studs at midspan, at 8.5 ft the center stud failed at midspan, and at 9 ft the inside face failed by rupture of the interior board transversely across the specimen at midspan. The set after a drop of 10 ft was 0.38 in., and the outside face was undamaged.

6. Racking Load

The results for wall specimens *BI–R1*, *R2*, and *R3* are shown in table 13 and in figure 37.

The racking loads were applied to the top plate only, and the stop was in contact with the floor plate only. In specimen *R1* at a load of 1.25 kips/ft there was noticeable vertical displacement between the interior boards at the joint and one interior board was cracked at the upper end near the loaded edge. In specimens *R2* and *R3* at a load of 1.375 kips/ft there was noticeable vertical displacement at the joint between the interior boards, some nails in the top plate pulling through the edge of the interior boards. At the maximum loads each of the specimens failed by the top plate pulling the nails from the studs and through the edges of the sheathing and interior board.

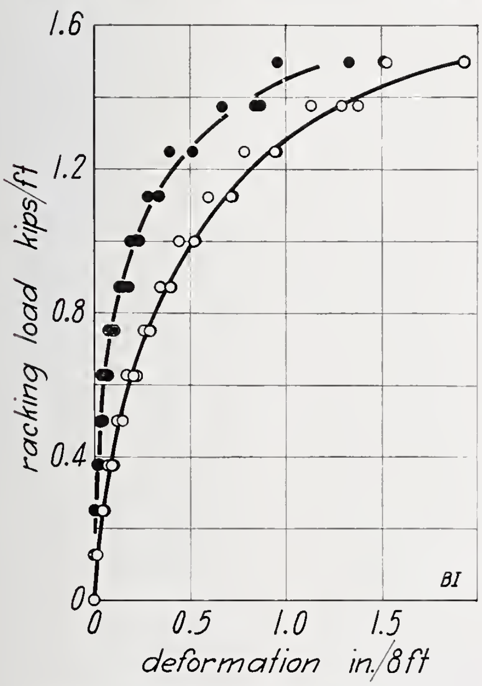

Figure 37.—*Racking load on wall BI.*

Load-deformation (open circles) and load-set (solid circles) results for specimens *BI–R1*, *R2*, and *R3*. The loads are in kips per foot of the face width of specimen (8 ft 0 in.).

VIII. WALL *BJ*

1. Description, Sponsor's Statement

This construction was a wood frame with "Bildrite" sheathing, sheathing paper, metal lath, and stucco on the outside face, and "Lok-Joint" lath and plaster on the inside face. It was similar to construction *BG*, with the exception that the sheathing on the outside face was covered by stucco, not bevel siding.

The price of this construction in Washington, D. C., as of July 1937, was \$0.40/ft^2.

(*a*) *Four-Foot Wall Specimens*

The 4-ft wall specimens were 8 ft 0 in. high, 4 ft 0 in. wide, and 6¾ in. thick. Each specimen consisted of a wood frame to which the faces were fastened. The frame consisted of three studs, *A*, shown in figure 38, fastened to a floor plate, *B*, and a top plate, *C*, by nails. The outside face consisted of wood nailing strips, *D*, insulating-board sheathing, *E*, sheathing paper, *F*, metal lath, *G*, and stucco, *H*. The inside face consisted of wood nailing strips, *D*, insulating-board lath, *I*, and plaster, *J*. The specimens were not painted.

Studs.—The studs, *A*, were red pine, 1⅝ by 3⅝ in. (nominal 2 by 4 in), 7 ft 7⅛ in. long, spaced 1 ft 4 in. on centers. The lower end of each stud was fastened to the floor plate by two 16d common nails driven from the bottom of the plate (not toenailed), and the upper end of each stud was fastened to the top plate by two 16d common nails driven from the top of the lower member of the plate.

Floor plate.—The floor plate, *B*, was red pine, 1⅝ by 3⅝ in. (nominal 2 by 4 in), 4 ft 0 in. long.

Top plate.—The top plate, *C*, consisted of two pieces of red pine, 1⅝ by 3⅝ in. (nominal 2 by 4 in.), 4 ft 0 in. long, fastened by ten 10d common nails driven from the top of the plate.

Nailing strips.—The nailing strips, *D*, were red pine, ¾ by ¾ in., 7 ft 7 in. long. In the specimen they supported the outer edges of the sheathing and the lath to facilitate stuccoing and plastering, but they are not used in a house.

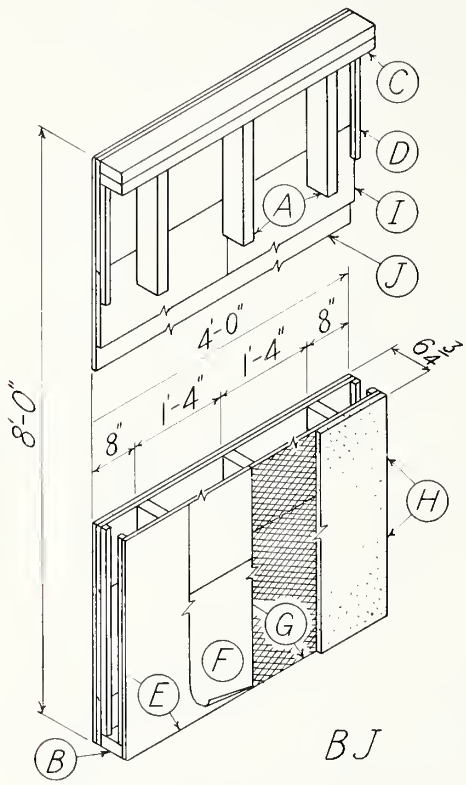

FIGURE 38.—*Four-foot wall specimen BJ.*

A, stud; *B*, floor plate; *C*, top plate; *D* nailing strip; *E*, sheathing; *F*, sheathing paper; *G*, metal lath; *H*, stucco; *I*, lath; *J*, plaster.

Sheathing.—The sheathing, *E*, was two "Bildrite" sheathing boards, 25/32 in. by 1 ft 11 15/16 in., 8 ft 0 in. long, with the linen-textured surface outward. There was a vertical joint on the center stud with ⅛-in. clearance between the vertical edges of the boards. The boards were fastened to the center stud, floor plate, and top plate by 8d common nails spaced 3 in., about ½ in. from the edges of the boards, and to the two outer studs by 8d common nails spaced 6 in.

Sheathing paper.—The sheathing paper, *F*, was laid horizontally across the sheathing and consisted of four sheets, 2 ft 8 in. wide, having three laps with the upper sheets lapping 10⅝ in. over the lower sheets. The paper was fastened with galvanized roofing nails, 1⅜ in. long, spaced 12 in. along the floor plate, 10 in. along the top plate, and with one nail at each stud through each lapped edge.

Metal lath.—The metal lath, *G*, was fastened over the sheathing paper and consisted of three sheets 4 ft 0 in. by 2 ft 3 in. and one sheet 4 ft 0 in. by 1 ft 7½ in. The lath was applied horizontally with three laps, the upper sheets lapping 1½ in. over the lower sheets. The lath was fastened to the studs, floor plate, and top plate by galvanized staples spaced 5 in., and to the nailing strips by galvanized roofing nails, 1⅜ in. long, spaced 4½ in. The overlapping edges of the lath were fastened together midway between studs with 18-gage galvanized steel wire.

Stucco.—The stucco, *H*, was about 1 in. thick and applied in three coats, two scratch coats and a sand-float finish.

Lath.—The lath, *I*, was "Lok-Joint" lath, five full courses and one course cut to a height of 7⅜ in., as shown in figure 6. The plaster was applied to the burlap-textured surface. There was a vertical joint in each course, centered on a stud, with 3/16-in. clearance between the ends of the lath. The horizontal joints (shiplapped) were reinforced by "Loks", three at each joint. The lath was fastened to the studs, floor plates, top plate, and nailing strips by plaster board nails spaced 4 in., about ½ in. from the edges of the lath.

Plaster.—The plaster, *J*, was ½ in. thick and consisted of a base coat and a finish coat. The lath was dry when the plaster was applied.

(b) *Eight-Foot Wall Specimens*

The 8-ft wall specimens were 8 ft 0 in. high, 8 ft 0 in. face width, and 6¾ in. thick. The specimens were similar to the 4-ft specimens, with the exception that there were seven studs spaced 1 ft 4 in. on centers and no nailing strips. There was a stud at each edge extending one-half its thickness beyond the faces; over-all width 8 ft 1⅝ in. The two members of the top plate were fastened by twenty 10d common nails.

The sheathing consisted of two boards 3 ft 11⅞ in. wide. There was a vertical joint over the center stud, with ⅛-in. clearance between the edges of the boards. The boards were fastened to the edge studs, center stud, floor plate, and top plate by 8d common nails spaced 3 in., about ½ in. from the edges of the boards, and to the other four studs by 8d common nails spaced 6 in.

2. Compressive Load

Wall specimen *BJ–C2* under compressive load is shown in figure 39. The results for wall

Figure 39.—*Wall specimen BJ–C2 under compressive load.*

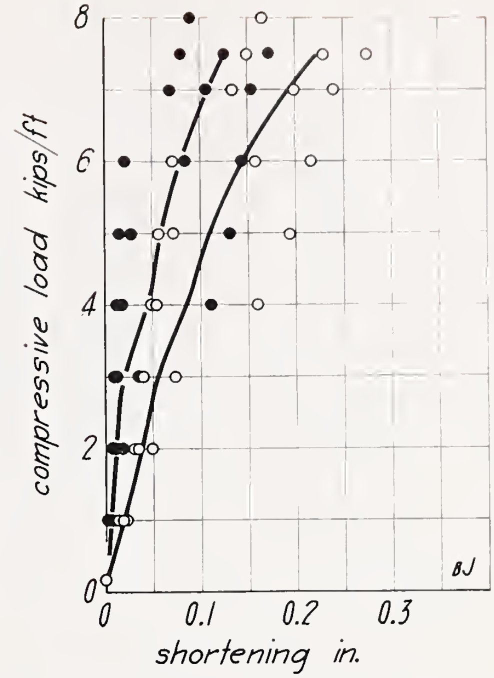

Figure 40.—*Compressive load on wall BJ.*

Load-shortening (open circles) and load-set (solid circles) results for specimens *BJ–C1*, *C2*, and *C3*. Load applied one-third the thickness (1.21 in.) from the inside surface of the studs. The loads are in kips per foot of actual width of specimen.

specimens *BJ–C1*, *C2*, and *C3* are shown in table 13 and in figures 40 and 41.

The lateral deflections shown in figure 41 are plotted to the right of the vertical axis for deflections of the specimens toward the outside face and to the left for deflections toward the inside face. No explanation was found for the deflections of the specimens toward the inside face under loads less than 6 kips/ft.

At loads of 6.5, 3.5, and 6 kips/ft on specimens *C1*, *C2*, and *C3*, respectively, the plaster spalled at one end of the specimen. At a load of 7.5 kips/ft on specimen *C3* the stucco cracked transversely across the specimen about 6 in. from the upper end. At the maximum loads specimens *C1* and *C3* failed by crushing of the lower member of the top plate locally at the inside edge of the studs. Specimen *C2* failed by the top plate crushing locally at the inside edge of the studs and separating at the outside edge. In specimen *C2* this rotation pulled the nails from the studs, ruptured the sheathing transversely across the specimen, and allowed the specimen to push out under load without breaking the studs.

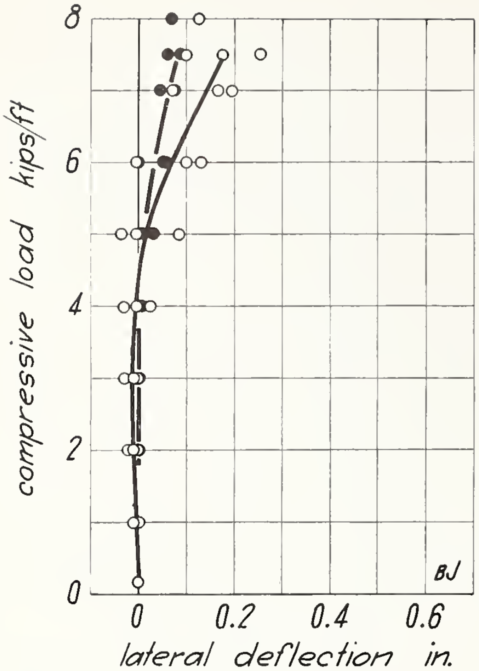

Figure 41.—*Compressive load on wall BJ.*

Load-lateral deflection (open circles) and load-lateral set (solid circles) results for specimens *BJ–C1*, *C2*, and *C3*. Load applied one-third the thickness (1.21 in.) from the inside surface of the studs. The loads are in kips per foot of actual width of specimen.

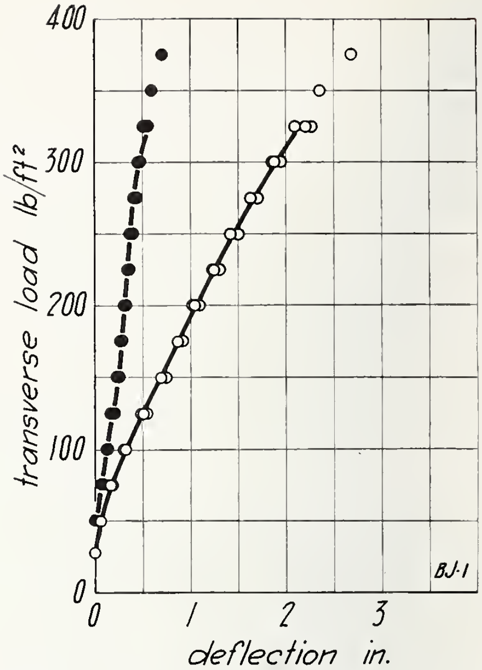

Figure 42.—*Transverse load on wall BJ, load applied to inside face.*

Load-deflection (open circles) and load-set (solid circles) results for specimens *BJ–T1*, *T2*, and *T3* on the span 7 ft 6 in.

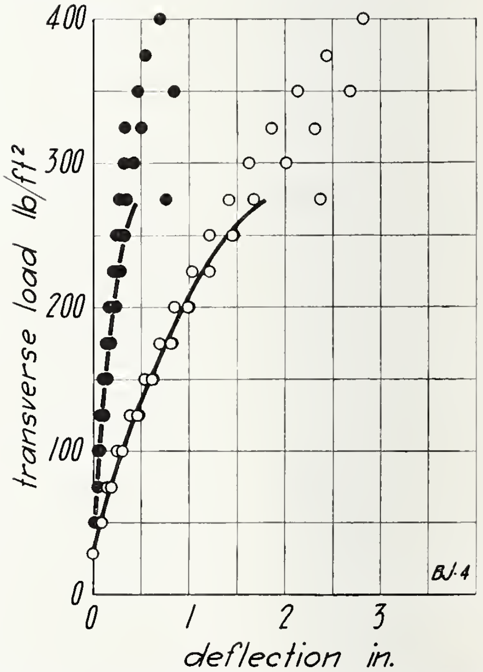

Figure 43.—*Transverse load on wall BJ, load applied to outside face.*

Load-deflection (open circles) and load-set (solid circles) results for specimens *BJ–T4*, *T5*, and *T6* on the span 7 ft 6 in.

3. Transverse Load

The results are shown in table 13 and in figure 42 for wall specimens *BJ–T1*, *T2*, and *T3*, loaded on the inside (plastered) face, and in figure 43 for wall specimens *BJ–T4*, *T5*, and *T6*, loaded on the outside (stuccoed) face.

In each of the specimens *T1*, *T2*, and *T3* the stucco cracked transversely across the specimen in several places either near or between the loading rollers. The first cracks occurred at loads of 97 lb/ft^2 on each specimen and deflections of 0.30, 0.28, and 0.30 in. in specimens *T1*, *T2*, and *T3*, respectively. In each of the specimens the plaster cracked longitudinally along the studs at the loading rollers and transversely across the specimen in several places. The first longitudinal cracks occurred at loads of 250, 275, and 150 lb/ft^2 and deflections of 1.50, 1.63, and 0.69 in. in specimens *T1*, *T2*, and *T3*, respectively. The first transverse cracks occurred at loads of 300, 275, and 300 lb/ft^2 and deflections of 1.95, 1.63, and 1.87 in. in specimens *T1*, *T2*, and *T3*, respectively. About one-half of the transverse cracks in the plaster occurred at lath joints. At the maximum loads specimens *T1* and *T3* failed by rupture of the center stud, one outer stud, and the sheathing at a loading roller. Specimen *T2* failed by rupture of all three studs and the sheathing at a loading roller.

In each of the specimens *T4*, *T5*, and *T6* (loaded on the stuccoed face) the plaster cracked transversely across the specimen at each of the lath joints and also between some of the lath joints. The first cracks occurred at loads of 100, 70, and 100 lb/ft^2, and deflections of 0.24, 0.15, and 0.31 in. in specimens *T4*, *T5*, and *T6*, respectively. For each of the specimens the stucco cracked transversely across the specimen at one or both loading rollers. The first cracks occurred at loads of 375, 250, and 200 lb/ft^2 and deflections of 2.43, 1.45, and 1.00 in. in specimens *T4*, *T5*, and *T6*, respectively. At the maximum load, specimen *T4* failed by rupture of all three studs at a loading roller. Specimen *T5* failed by rupture of the center stud and one outer stud between the loading rollers. Specimen *T6* failed by rupture of both outer studs between the loading rollers.

4. Concentrated Load

The results are shown in table 13 and in figure 44 for specimens *BJ–P1*, *P2*, and *P3*, loaded on the inside (plastered) face, and in figure 45 for specimens *BJ–P4*, *P5*, and *P6*, loaded on the outside (stuccoed) face.

The concentrated loads were applied to the inside face of specimens *P1*, *P2*, and *P3* on the plaster midway between two studs and about 4 ft from one end. Each of the specimens failed by punching of the disk through the plaster and into the lath.

The concentrated loads were applied to the outside face of specimens *P4*, *P5*, and *P6* on the stucco midway between two studs and about 4 ft from the lower end. The indentations after a load of 1,000 lb had been applied were 0.005, 0.006, and 0.011 in. in specimens *P4*, *P5*, and *P6*, respectively, and no other effect was observed.

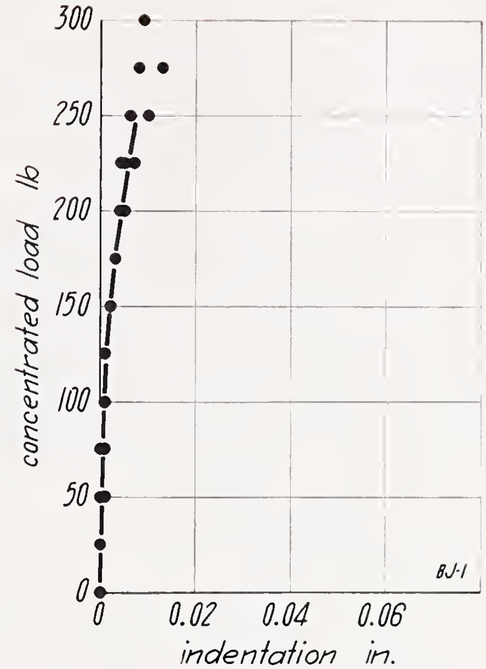

Figure 44.—*Concentrated load on wall BJ, load applied to inside face.*

Load-indentation results for specimens *BJ–P1*, *P2*, and *P3*.

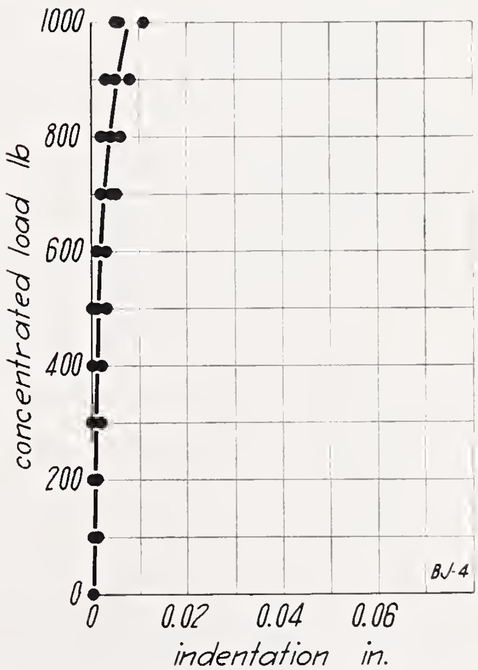

Figure 45.—*Concentrated load on wall BJ, load applied to outside face.*

Load-indentation results for specimens *BJ–P4*, *P5*, and *P6*.

5. Impact Load

The results are shown in table 13 and in figure 46 for wall specimens *BJ–I1*, *I2*, and *I3*, loaded on the inside face, and in figure 47 for wall specimens *BJ–I4*, *I5*, and *I6*, loaded on the outside face.

The impact loads were applied to the center of the inside face of specimens *I1*, *I2*, and *I3*, the sandbag striking the plaster directly over the center stud. In each of the specimens *I1*, *I2*, and *I3* at drops of 2.5, 2, and 2.5 ft and deflections of 0.49, 0.40, and 0.47 in., respectively, the stucco cracked either along or diagonally across the center stud. At drops of 3, 4.5, and 4 ft, respectively, the inside face of each specimen failed by rupture of the plaster where the sandbag struck. At drops of 4, 8, and 6 ft and deflections of 0.88, 1.61, and 1.22 in., respectively, the stucco cracked transversely across each specimen near midspan. In specimens *I1* and *I3* at a drop of 8 ft the outside face of each specimen failed by opening of the cracks in the stucco. In specimen *I1* the center stud broke at midspan at a drop of 9.5 ft. The sets after a drop of 10 ft were 0.85, 0.34, and 0.71 in. in specimens *I1*, *I2*, and *I3*, respectively.

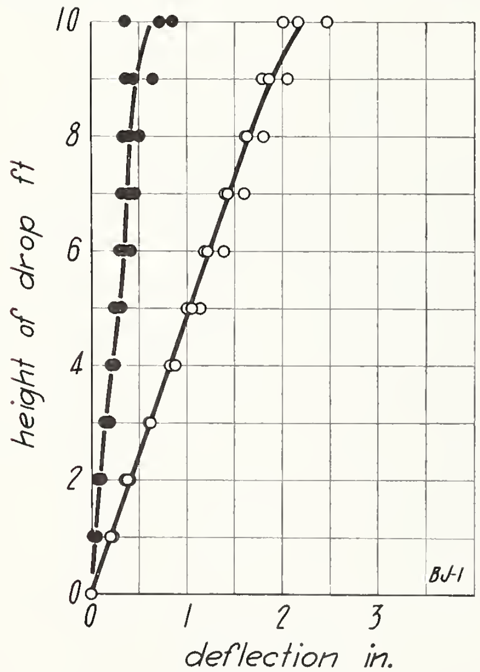

Figure 46.—*Impact load on wall BJ, load applied to inside face.*

Height of drop-deflection (open circles) and height of drop-set (solid circles) results for specimens *BJ–I1*, *I2*, and *I3* on the span 7 ft 6 in.

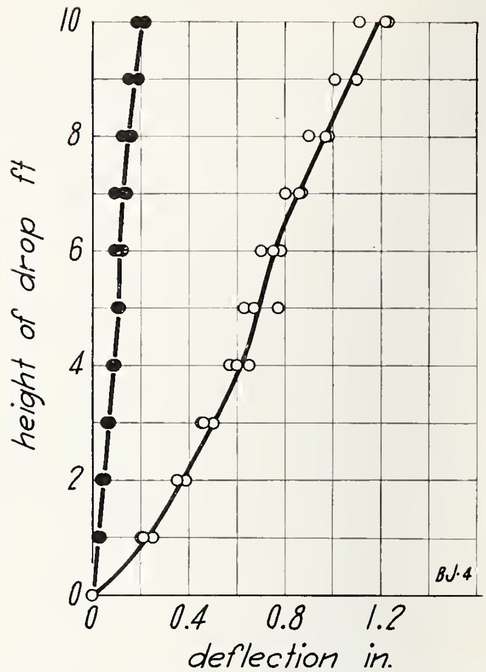

Figure 47.—*Impact load on wall BJ, load applied to outside face.*

Height of drop-deflection (open circles) and height of drop-set (solid circles) results for specimens *BJ–I4*, *I5*, and *I6* on the span 7 ft 6 in.

The impact loads were applied to the center of the outside face of specimens *I4*, *I5*, and *I6*, the sand bag striking the stucco directly over the center stud. In each of the specimens *I4*, *I5*, and *I6* at drops of 3.5, 1, and 3.5 ft and deflections of 0.58, 0.20, and 0.54 in., respectively, the plaster cracked transversely across each specimen at a lath joint near midspan. At drops of 6.5, 5.5, and 5 ft for specimens *I4*, *I5*, and *I6*, respectively, the inside face of each specimen failed by opening of the cracks in the plaster. In each of the specimens the stucco cracked longitudinally at drops of 6.0, 6.5, and 6.5 ft and deflections of 0.78, 0.75, and 0.79 in., respectively, and transversely at drops of 7.5, 8.5, and 10 ft and deflections of 0.90, 0.95, and 1.23 in., respectively. In specimen *I4* the outside face failed by opening of a longitudinal crack over the center stud. The sets after a drop of 10 ft were 0.18, 0.22, and 0.22 in. in specimens *I4*, *I5*, and *I6*, respectively, and the studs and sheathing and lath were undamaged.

6. Racking Load

The results for wall specimens *BJ–R1*, *R2*, and *R3* are shown in table 13 and in figure 48.

The racking loads were applied to the top plate only, and the stop was in contact with the floor plate only. In each of the specimens the plaster cracked in several places approximately parallel to a diagonal from the point of application of load to the stop. The first cracks occurred at loads of 1.625, 1.750, and 1.750 kips/ft and deformations of 0.50, 0.46, and 0.56 in./8 ft in specimens *R1*, *R2*, and *R3*, respectively. At the maximum load each of the specimens failed by shearing of the plaster from the lath, pulling of some of the nails through the edges of the sheathing, and pulling the top plate from the studs. The stucco was undamaged.

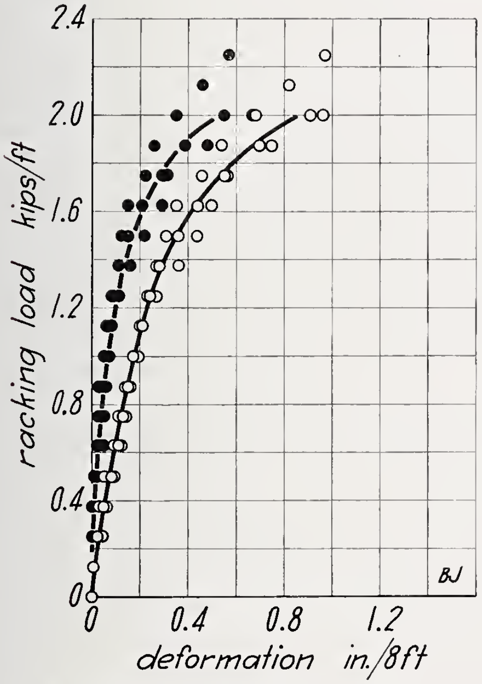

Figure 48.—*Racking load on wall BJ.*

Load-deformation (open circles) and load-set (solid circles) results for specimens *BJ–R1*, *R2*, and *R3*. The loads are in kips per foot of the face width of specimen (8 ft 0 in).

IX. WALL *BK*

1. Description, Sponsor's Statement

This construction was a wood frame with "Bildrite" sheathing and brick veneer on the outside face and "Lok-Joint" lath and plaster on the inside face. It was similar to construction *BG*, with the exception that the sheathing on the outside face was covered by brick veneer, not bevel siding. It was similar to construction *BJ*, with the exception that the sheathing on the outside face was covered by brick veneer, not stucco.

The price in Washington, D. C., as of July 1937, was \$0.53/ft^2.

(a) *Four-Foot Wall Specimens*

The 4-ft wall specimens were 8 ft 0 in. high, 4 ft 0 in. wide, and 10¼ in. thick. Each specimen consisted of a wood frame to which the faces were fastened. The frame consisted of three studs, *A*, shown in figure 49, fastened to a floor plate, *B*, and a top plate, *C*, by nails. The outside face consisted of insulating-board sheathing, *D*, and brick veneer, *E*, fastened to the studs by wall ties. The inside face consisted

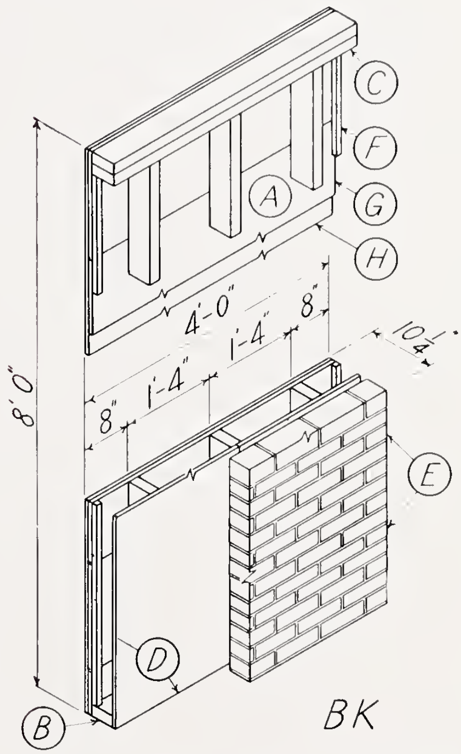

Figure 49.—*Four-foot wall specimen BK.*

A, stud; *B*, floor plate; *C*, top plate; *D*, sheathing; *E*, brick veneer; *F*, nailing strips; *G*, lath; *H*, plaster.

of wood nailing strips, *F*, insulating-board lath, *G*, and plaster, *H*. The specimens were not painted.

Studs.—The studs, *A*, were red pine, 1⅝ by 3⅝ in. (nominal 2 by 4 in), 7 ft 7⅛ in. long, spaced 1 ft 4 in. on centers. The lower end of each stud was fastened to the floor plate by two 16d common nails driven from the bottom of the plate (not toenailed), and the upper end of each stud was fastened to the top plate by two 16d common nails driven from the top of the lower member of the plate.

Floor plate.—The floor plate, *B*, was red pine, 1⅝ by 3⅝ in. (nominal 2 by 4 in), 4 ft 0 in. long.

Top plate.—The top plate, *C*, consisted of two pieces of red pine, 1⅝ by 3⅝ in. (nominal 2 by 4 in), 4 ft 0 in. long, fastened by ten 10d common nails driven from the top of the plate.

Sheathing.—The sheathing, *D*, was two "Bild-rite" sheathing boards, 25/32 in. by 1 ft 11 15/16 in., 8 ft 0 in. long, with the linen-textured surface outward. There was a vertical joint on the center stud, with ⅛-in. clearance between the edges of the boards. The boards were fastened to the center stud, floor plate, and top plate by 8d common nails spaced 3 in., about ½ in. from the edges of the boards, and to the two outer studs by 8d common nails spaced 6 in.

Brick veneer.—The brick veneer, *E*, was laid with No. 1 common red brick in running bond with ½-in. mortar joints. The brick veneer was fastened to the studs by corrugated sheet-steel wall ties. Three ties were laid in every third course, one at each stud, fastened by either one or two 6d box nails. The design for the wall provided a 1-in. cavity between the brick and sheathing. In the specimens this cavity was not clear because mortar accumulated in irregular patches.

Nailing strips.—The nailing strips, *F*, were red pine, ¾ by ¾ in., 7 ft 7⅛ in. long. In the specimen they supported the outer edge of the lath to facilitate plastering, but they are not used in a house.

Lath.—The lath, *G*, consisted of "Lok-Joint" lath, five full courses and one course cut to a height of 7⅜ in., as shown in figure 6. The plaster was on the burlap-textured surface. There was a vertical joint in each course, centered on a stud, with 3/16-in. clearance between the ends of the lath. The horizontal joints (shiplapped) were reinforced by "Loks," three at each joint. The lath was fastened to the studs, floor plate, top plate, and nailing strips by plasterboard nails spaced 4 in. on centers and about ½ in. from the edges of the lath.

Plaster.—The plaster, *H*, was ½ in. thick and consisted of a base coat and a finish coat. The lath was dry when the plaster was applied.

(*b*) *Eight-Foot Wall Specimens*

The 8-ft wall specimens were 8 ft 0 in. high, 8 ft 0 in. face width, by 10¼ in. thick. The specimens were similar to the 4-ft specimens, with the exception that there were seven studs spaced 1 ft 4 in. on centers and no nailing strips. There was a stud at each edge extending one-half its thickness beyond the faces; over-all width 8 ft 1⅝ in. The two members of the top plate were fastened by twenty 10d common nails.

Sheathing.—The sheathing consisted of two boards 3 ft 11⅞ in. wide. There was a vertical joint on the center stud, with ⅛-in. clearance between the edges of the boards.

The boards were fastened to the edge studs, center stud, floor plate, and top plate by 8d common nails spaced 3 in., about ½ in. from the edges of the boards, and to the other four studs by 8d common nails spaced 6 in.

2. Compressive Load

The results for wall specimens *BK–C1*, *C2*, and *C3* are shown in table 13 and in figures 50 and 51.

The upper loading plate was not in contact with the brick veneer. The lateral deflections shown in figure 51 are plotted to the right of the vertical axis for deflections of the specimens toward the outside face and to the left for deflections toward the inside face. Specimens *C1* and *C3* deflected toward the inside face for all loads up to and including the maximum load. Specimen *C2* deflected toward the outside face for almost all loads. The lateral deflections of specimens *C1* and *C3* toward the inside face were probably due either to the stiffness of the inside face counteracting the effect of the eccentric loads or to the little resistance afforded by the brick veneer to deflection in this direction.

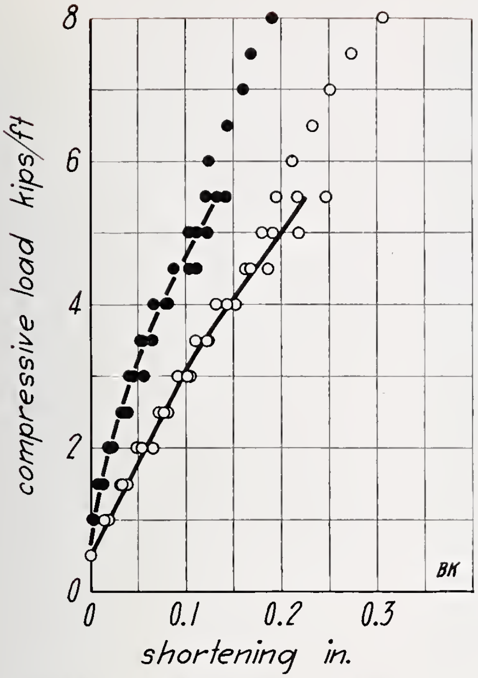

FIGURE 50.—*Compressive load on wall BK.*

Load-shortening (open circles) and load-set (solid circles) results for specimens *BK–C1*, *C2*, and *C3*. Load applied to the wood frame only, one-third the thickness (1.21 in.) from the inside surface of the studs. The loads are in kips per foot of actual width of specimen.

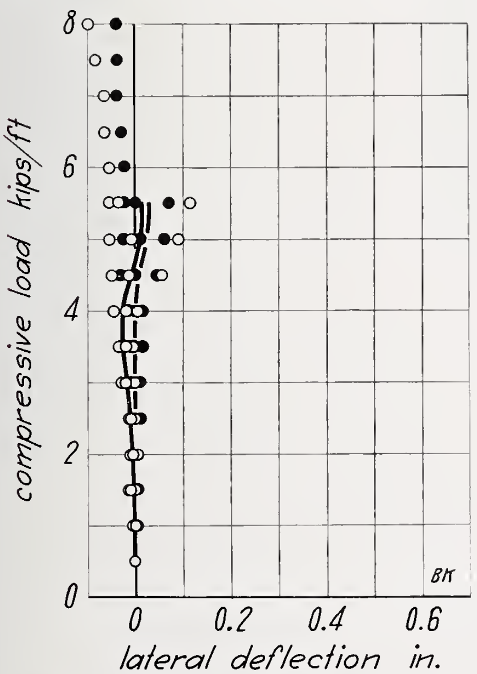

FIGURE 51.—*Compressive load on wall BK.*

Load-lateral deflection (open circles) and load-lateral set (solid circles) results for specimens *BK–C1*, *C2*, and *C3*. Load applied to the wood frame only, one-third the thickness (1.21 in.) from the inside surface of the studs. The loads are in kips per foot of actual width of specimen.

Each of the specimens failed by the top plate crushing locally at the inside edge of the studs and separating at the outside edge. This rotation of the top plate pulled the nails from the studs, ruptured the sheathing transversely across most of the width of the specimen, and either ruptured the lath or separated it from the upper ends of the studs. No failure of the brick veneer was observed.

3. Transverse Load

Wall specimen *BK–T3* under transverse load is shown in figure 52. The results are shown in table 13 and in figure 53 for wall specimens *BK–T1*, *T2*, and *T3*, loaded on the inside (plastered) face, and in figure 54 for wall specimens *BK–T4*, *T5*, and *T6*, loaded on the outside (brick-veneer) face.

The deflections of the studs and of the brick veneer were each measured. The lateral deflections shown in figures 53 and 54 are the average of these values.

In each of the specimens *T1*, *T2*, and *T3* the brick veneer cracked at three or four bed joints owing to rupture of the bond between the brick and the mortar. The first cracks occurred at or between the loading rollers at loads of 75, 50, and 50 lb/ft^2 and deflections of 0.38, 0.19, and 0.17 in. in specimens *T1*, *T2*, and *T3*, respectively. In each of the specimens the plaster cracked longitudinally along either one or both outer studs and transversely across the specimen at each lath joint. The first longitudinal cracks occurred at loads of 200, 150, and 150 lb/ft^2 and deflections of 1.41, 0.97, and 1.01 in. in specimens *T1*, *T2*, and *T3*, respectively. The first transverse cracks occurred at or between loading rollers at loads of 150, 175, and 225 lb/ft^2 and deflections of 0.96, 1.23, and 1.80 in. in specimens *T1*, *T2*, and *T3*, respectively. At the maximum loads each of the specimens *T1*, *T2*, and *T3* failed by rupture of one outer stud at the upper loading roller and lateral displacement of the lower portion of the brick veneer with respect to the upper portion at a ruptured bed joint.

In each of the specimens *T4*, *T5*, and *T6* (loaded on the brick veneer) the brick veneer cracked at four or five bed joints owing to rupture of the bond between the brick and the mortar. The first cracks occurred at or near

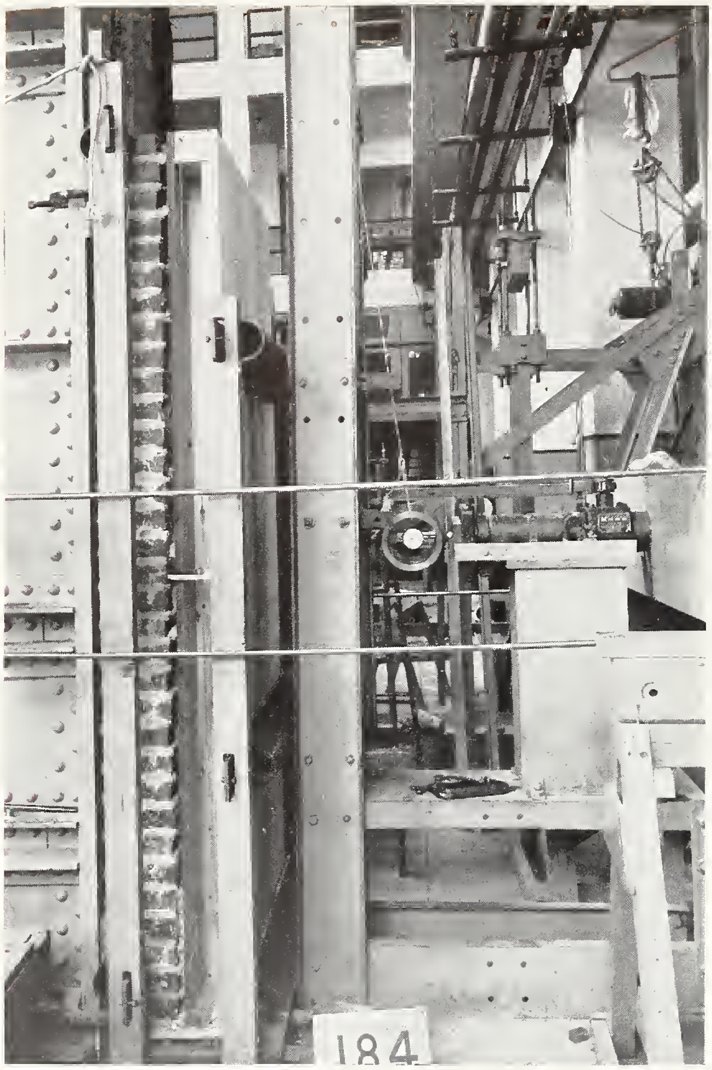

Figure 52.—*Wall specimen BK–T3, under transverse load.*

the upper loading roller at loads of 64, 85, and 75 lb/ft^2 and deflections of 0.16, 0.17, and 0.21 in. in specimens *T4*, *T5*, and *T6*, respectively. In each of the specimens the plaster cracked transversely across the specimen in several places. About one-half of the cracks were at lath joints. The first cracks occurred near the upper loading roller at loads of 124, 100, and 132 lb/ft^2 and deflections of 0.76, 0.32, and 0.66 in. in specimens *T4*, *T5*, and *T6*, respectively. At the maximum load specimens *T4* and *T6* failed by rupture of one outer stud at a loading roller and lateral displacement of the brick veneer at a ruptured bed joint. Specimen *T5* failed by rupture of the center stud and one outer stud at midspan.

4. Concentrated Load

The results are shown in table 13 and in figure 55 for wall specimens *BK–P1*, *P2*, and *P3*, loaded on the inside face, and in figure 56 for wall specimens *BK–P4*, *P5*, and *P6*, loaded on the outside face.

The concentrated loads were applied to the inside face of specimens *P1*, *P2*, and *P3* on the plaster midway between two studs and about 3 ft from the lower end. Each of the specimens failed by punching of the disk through the plaster and into the lath.

The concentrated loads were applied to the outside face of specimens *P4*, *P5*, and *P6* on a brick at midwidth in a course midway between

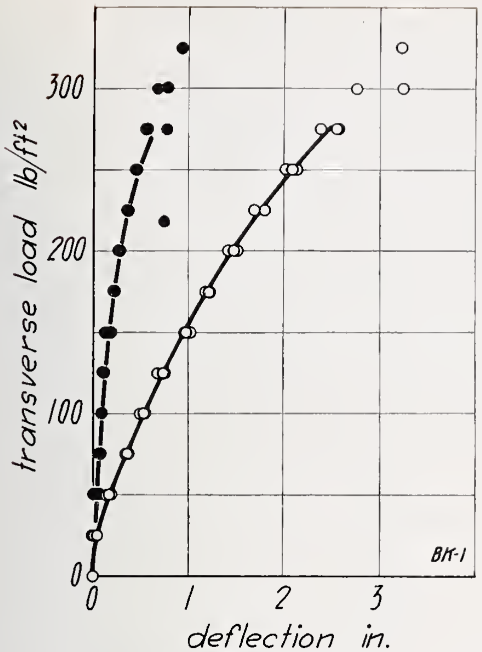

FIGURE 53.—*Transverse load on wall BK, load applied to inside face.*

Load-deflection (open circles) and load-set (solid circles) results for specimens *BK–T1*, *T2*, and *T3* on the span 7 ft 6 in.

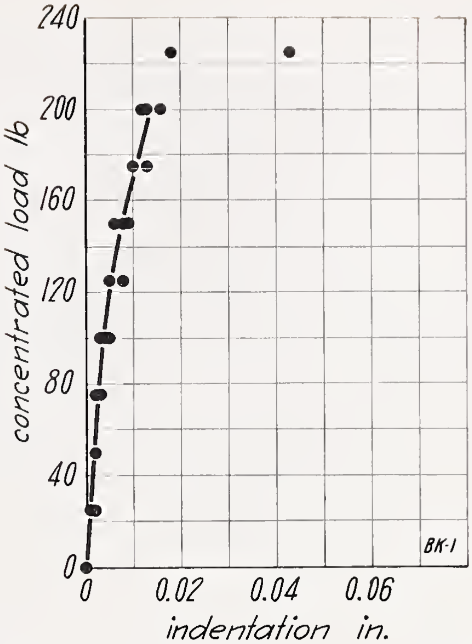

FIGURE 55.—*Concentrated load on wall BK, load applied to inside face.*

Load-indentation results for specimens *BK–P1*, *P2*, and *P3*.

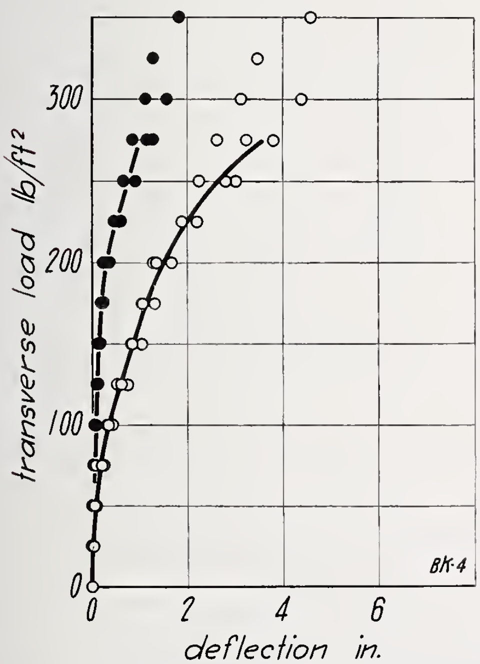

FIGURE 54.—*Transverse load on wall BK, load applied to outside face.*

Load-deflection (open circles) and load-set (solid circles) results for specimens *BK–T4*, *T5*, and *T6* on the span 7 ft 6 in.

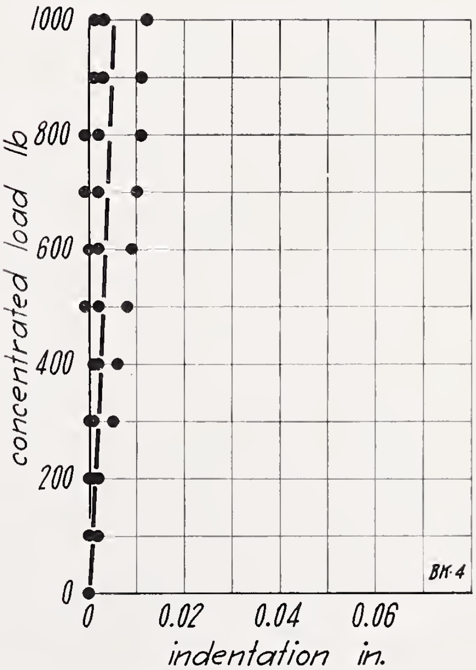

FIGURE 56.—*Concentrated load on wall BK, load applied to outside face.*

Load-indentation results for specimens *BK–P4*, *P5*, and *P6*.

wall ties, about 3½ ft from the lower end. The indentations after a load of 1,000 lb had been applied were 0.001, 0.012, and 0.003 in. in specimens *P4*, *P5*, and *P6*, respectively, and no further effect was observed.

5. Impact Load

The results are shown in table 13 and in figure 57 for wall specimens *BK–I1*, *I2*, and *I3*, loaded on the inside face, and in figure 58 for wall specimens *BK–I4*, *I5*, and *I6*, loaded on the outside face.

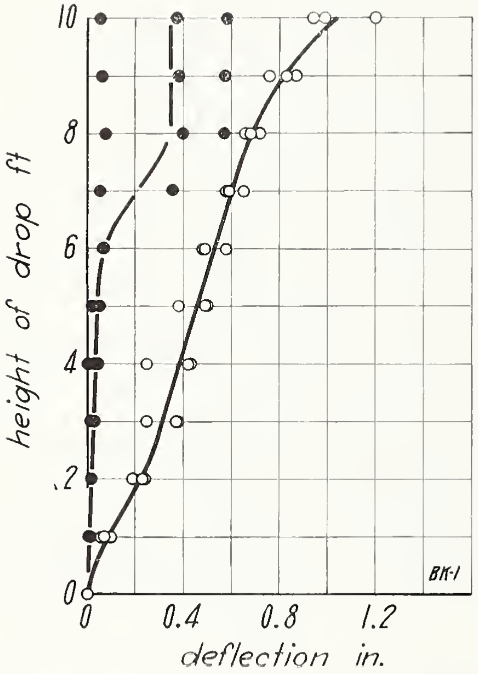

Figure 57.—*Impact load on wall BK, load applied to inside face.*

Height of drop-deflection (open circles) and height of drop-set (solid circles) results for specimens *BK–I1*, *I2*, and *I3* on the span 7 ft 6 in.

The specimens were vertical when tested. The impact loads were applied to the center of the inside face of specimens *I1*, *I2*, and *I3*, the sandbag striking the plaster directly over the center stud. At drops of 3.5, 3.5, and 2.5 ft on specimens *I1*, *I2*, and *I3*, respectively, the inside face failed by rupture of the lath and plaster where the bag struck. At drops of 3, 2.5, and 3.5 ft, and deflections of 0.38, 0.32, and 0.25 in., respectively, the brick veneer of each specimen cracked by rupture of the bond between the brick and mortar at a bed joint near midspan. At drops of 6, 6, and 7.5 ft on specimens *I1*, *I2*, and *I3*, respectively, the outside face of each specimen failed by lateral displacement of the brick veneer at a ruptured bed joint. The sets after a drop of 10 ft were 0.58, 0.37, and 0.05 in., respectively, and the studs were undamaged.

The impact loads were applied to the center of the outside face of specimens *I4*, *I5*, and *I6*, the sandbag striking the brick veneer directly over the center stud. In specimens *I4* and *I5* at drops of 7 and 9 ft and deflections of 0.42 and 0.42 in., respectively, the brick veneer of

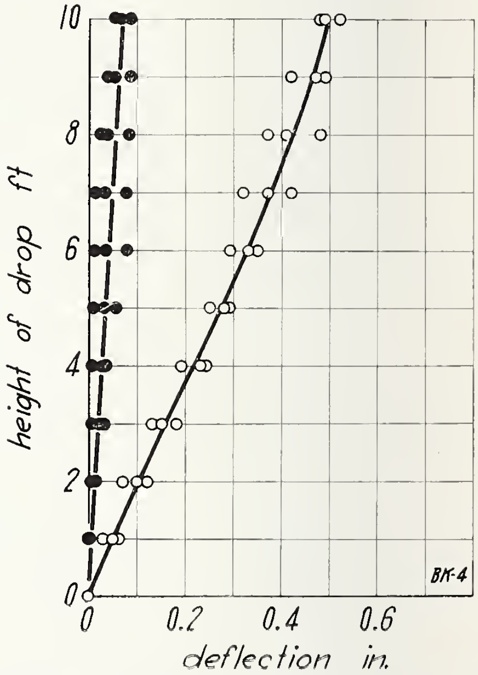

Figure 58.—*Impact load on wall BK, load applied to outside face.*

Height of drop-deflection (open circles) and height of drop-set (solid circles) results for specimens *BK–I4*, *I5*, and *I6* on the span 7 ft 6 in.

each specimen cracked owing to rupture of the bond between the brick and the mortar at a bed joint near midspan. In specimen *I4* at a drop of 10 ft and a deflection of 0.52 in., the plaster cracked transversely across the specimen near midspan. The sets after a drop of 10 ft were 0.08, 0.07, and 0.05 in. in specimens *I4*, *I5*, and *I6*, respectively, and neither the faces nor the studs failed.

6. Racking Load

The results for wall specimens *BK–R1*, *R2*, and *R3* are shown in table 13 and in figure 59.

The racking loads were applied near the upper end of each specimen to a bearing plate covering the total thickness of the specimen, including the brick veneer. On specimen *R1* the center of the load was at midthickness of the specimen and on specimens *R2* and *R3* at 2.5 in. from the outside face. The stop was in contact over the total thickness of the specimens. The deformations and sets shown in figure 59 for a height of 8 ft were computed from the values obtained from the measuring-device readings. The gage length of the vertical measuring device was 6 ft 9 in. The gage length of the horizontal measuring device was 5 ft. The deformations and sets are the averages of the deformations and sets for the wood frame and for the brick veneer measured independently by two sets of deformation-measuring devices.

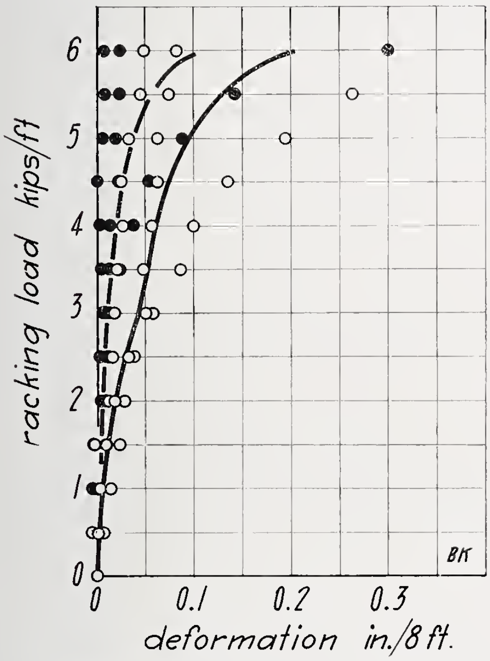

Figure 59.—*Racking load on wall BK.*

Load-deformation (open circles) and load-set (solid circles) results for specimens *BK–R1*, *R2*, and *R3*. The loads are in kips per foot of the face width of specimen (8 ft 0 in).

In specimen *R1* at a load of 6 kips/ft and a deformation of 0.46 in./8 ft, the plaster cracked diagonally in several places, approximately parallel to a diagonal from the point of application of load to the stop. There was also noticeable vertical displacement between the sheathing boards at the joint. During the application of the next increment of load the wood frame deformed so much more than the brick veneer that the ring dynamometer slipped out of the frame. The ring dynamometer was then centered 2.5 in. from the outside face, a load of 6.25 kips/ft was applied, and no further effect was observed.

Specimen *R2* failed by rupture of the brick veneer in a stepwise crack approximately along a diagonal from the point of application of load to the stop. The crack usually followed the bed and head joints but went through the brick in a few places. No other failure of the specimen was observed. In specimen *R3* the set after a load of 6.25 kips/ft had been applied was 0.026 in./8 ft, and no further effect was observed.

X. WALL *BL*

1. Description, Sponsor's Statement

This construction was a wood frame with "Bildrite" sheathing, wood furring strips, and wood shingles on the outside face and "Lok-Joint" lath and plaster on the inside face. It was similar to construction *BG*, with the exception that the sheathing on the outside face was covered by shingles, not bevel siding.

The price in Washington, D. C., as of July 1937, was \$0.36/ft^2.

(a) *Four-Foot Wall Specimens*

The 4-ft wall specimens were 8 ft 0 in. high, 4 ft 0 in. wide, and 7 in. thick. Each specimen consisted of a wood frame to which the faces were fastened. The frame consisted of three studs, *A*, shown in figure 60, fastened to a floor plate, *B*, and a top plate, *C*, by nails. The outside face consisted of insulating-board sheathing, *D*, wood furring strips, *E*, and wood shingles, *F*. The inside face consisted of wood nailing strips, *G*, insulating-board lath, *H*, and plaster, *I*. The specimens were not painted.

Studs.—The studs, *A*, were red pine, 1⅝ by 3⅝ in. (nominal 2 by 4 in), 7 ft 7⅛ in. long, spaced 1 ft 4 in. on centers. The lower end of each stud was fastened to the floor plate by two 16d common nails driven from the bottom of the plate (not toenailed), and the upper end of each stud was fastened to the top plate by two 16d common nails driven from the top of the lower member of the plate.

Floor plate.—The floor plate, *B*, was red pine, 1⅝ by 3⅝ in. (nominal 2 by 4 in), 4 ft 0 in. long.

Top plate.—The top plate, *C*, consisted of two pieces of red pine, 1⅝ by 3⅝ in. (nominal 2 by 4 in), 4 ft 0 in. long, fastened by ten 10d common nails driven from the top of the plate.

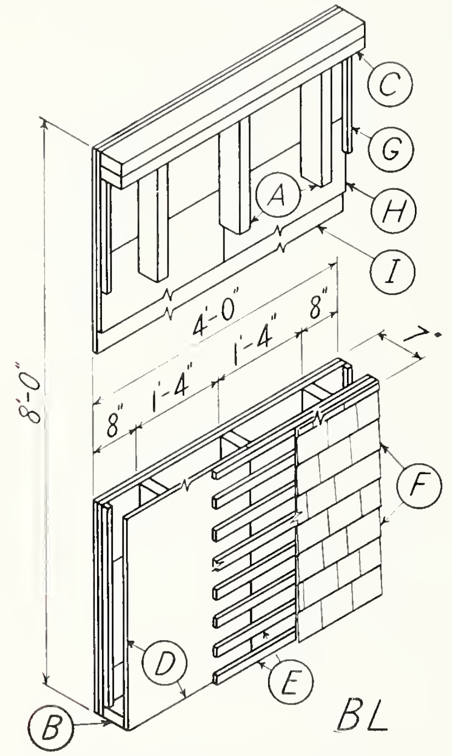

FIGURE 60.—*Four-foot wall specimen BL.*

A, stud; *B*, floor plate; *C*, top plate; *D*, sheathing; *E*, furring strip; *F*, shingles; *G*, nailing strip; *H*, lath; *I*, plaster.

Sheathing.—The sheathing, *D*, was two "Bildrite" sheathing boards, 25/32 in. by 1 ft 11 15/16 in., 8 ft 0 in. long, with the linen-textured surface outward. There was a vertical joint on the center stud with ⅛-in. clearance between the edges of the boards. The boards were fastened to the center stud, floor plate, and top plate by 8d common nails spaced 3 in., about ½ in. from the edges of the boards, and to the two outer studs by 8d common nails spaced 6 in.

Furring strips.—The furring strips, *E*, were 20 pieces of red pine, ¾ by 1⅝ in., 4 ft 0 in. long, spaced 5 in., and fastened to the studs by 10d box nails, one at each stud.

Shingles.—The shingles, *F*, were western red cedar, 16 in. long, exposed 5 in. to the weather, and fastened to the furring strips by 3d galvanized common nails, either two or three nails in each shingle.

Nailing strips.—The nailing strips, *G*, were red pine, ¾ by ¾ in., 7 ft 7 in. long. In the specimen they supported the outer edge of the lath to facilitate plastering, but they are not used in a house.

Lath.—The lath, *H*, consisted of "Lok-Joint" lath, five full courses and one course cut to a height of 7⅜ in., as shown in figure 6. The plaster was applied to the burlap-textured surface. There was a vertical joint in each course, centered on a stud, with 3/16-in. clearance between the ends of the lath. The horizontal joints (shiplapped) were reinforced by "Loks," three at each joint. The lath was fastened to the studs, floor plate, top plate, and nailing strips by plasterboard nails spaced 4 in., about ½ in. from the edges of the lath.

Plaster.—The plaster, *I*, was ½ in. thick and consisted of a base coat and a finish coat. The lath was dry when the plaster was applied.

(*b*) *Eight-Foot Wall Specimens*

The 8-ft wall specimens were 8 ft 0 in. high, 8 ft 0 in. face width, and 7 in. thick. The specimens were similar to the 4-ft specimens, with the exception that there were seven studs spaced 1 ft 4 in. on centers and no nailing strips. There was a stud at each edge extending one-half its thickness beyond the faces; over-all width 8 ft 1⅝ in. The two members of the top plate were fastened by twenty 10d common nails. The sheathing consisted of two boards, 3 ft 11⅞ in. wide. There was a vertical joint over the center stud, with ⅛-in. clearance between the edges of the boards. The sheathing was fastened to the edge studs, center stud, floor plate, and top plate by 8d common nails spaced 3 in., about ½ in. from the edges of the boards, and to the other four studs by 8d common nails spaced 6 in.

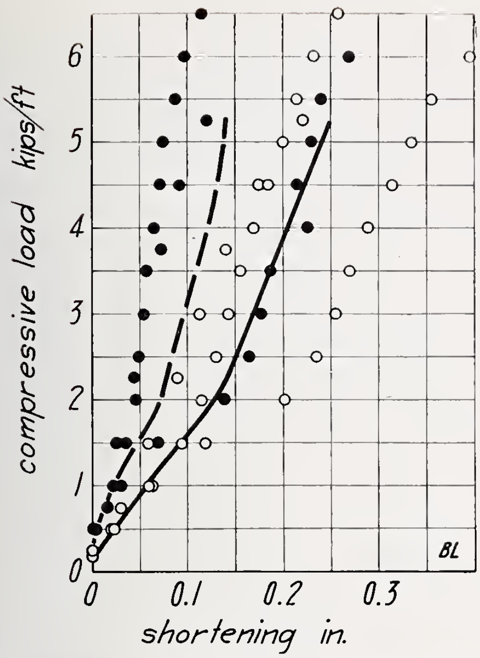

FIGURE 61.—*Compressive load on wall BL.*

Load-shortening (open circles) and load-set (solid circles) results for specimens *BL–C1, C2*, and *C3*. Load applied one-third the thickness (1.21 in.) from the inside surface of the studs. The loads are in kips per foot of actual width of specimen.

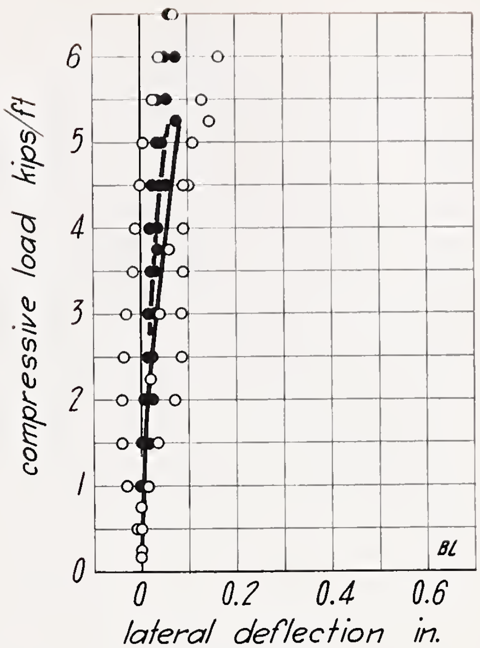

FIGURE 62.—*Compressive load on wall BL.*

Load-lateral deflection (open circles) and load-lateral set (solid circles) results for specimens *BL–C1, C2*, and *C3*. Load applied one-third the thickness (1.21 in.) from the inside surface of the studs. The loads are in kips per foot of actual width of specimen.

2. Compressive Load

The results for wall specimens *BL–C1*, *C2*, and *C3* are shown in table 13 and in figures 61 and 62.

The lateral deflections shown in figure 62 were plotted to the right of the vertical axis for deflections of the specimens toward the outside face and to the left for deflections toward the inside face. Specimen *C3* deflected toward the inside face for loads up to 4.5 kips/ft, probably owing to the stiffness of the inside face counteracting the effect of the eccentric load.

Each of the specimens failed by crushing of the lower member of the top plate, locally, at the inside edge of the studs, causing the plate to rotate and allowing the specimens to push out under load without breaking the studs.

3. Transverse Load

The results are shown in table 13 and in figure 63 for wall specimens *BL–T1*, *T2*, and *T3*, loaded on the inside (plastered) face, and in figure 64 for wall specimens *T4*, *T5*, and *T6*, loaded on the outside (shingled) face.

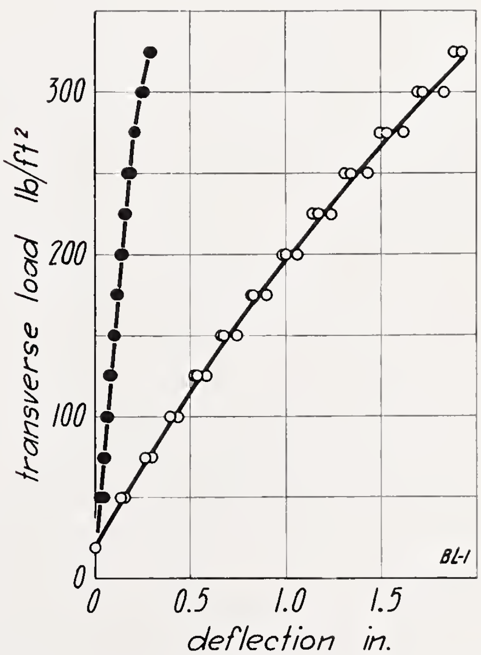

FIGURE 63.—*Transverse load on wall BL, load applied to inside face.*

Load-deflection (open circles) and load-set (solid circles) results for specimens *BL–T1*, *T2*, and *T3* on the span 7 ft 6 in.

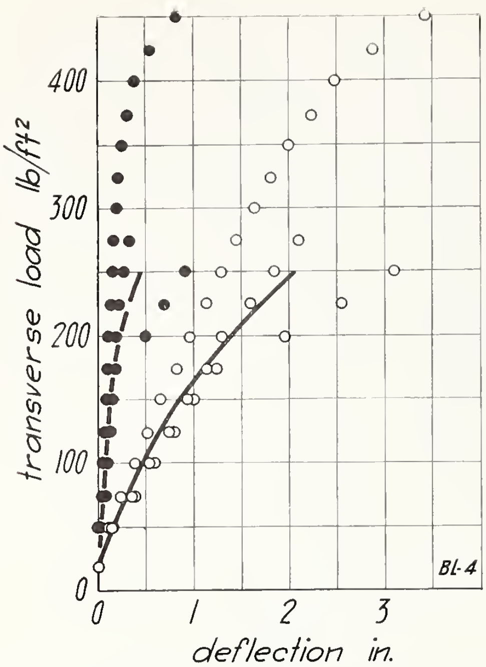

FIGURE 64.—*Transverse load on wall BL, load applied to outside face.*

Load-deflection (open circles) and load-set (solid circles) results for specimens *BL–T4*, *T5*, and *T6* on the span 7 ft 6 in.

In each of the specimens *T1*, *T2*, and *T3*, the plaster cracked longitudinally along one or both outer studs and transversely across the specimen in several places. The first longitudinal cracks occurred at loads of 225, 75, and 75 lb/ft² and deflections of 1.14, 0.26, and 0.29 in. in specimens *T1*, *T2*, and *T3*, respectively. Some of the transverse cracks occurred at lath joints. The first transverse cracks occurred at or between the loading rollers at loads of 225, 200, and 175 lb/ft² and deflections of 1.14, 1.00, and 0.90 in. in specimens *T1*, *T2*, and *T3*, respectively. At the maximum loads each of the specimens failed by rupture of the center stud, one outer stud, and the sheathing at or between the loading rollers. In addition, in specimen *T1*, some of the shingles separated from the furring strips where the studs ruptured.

In each of the specimens *T4*, *T5*, and *T6* (loaded on the shingles) the plaster cracked transversely across the specimen in several places. Some of the cracks occurred at lath joints. The first cracks occurred at loads of 75, 60, and 75 lb/ft² and deflections of 0.34, 0.24, and 0.23 in. in specimens *T4*, *T5*, and *T6*, respectively. At the maximum load specimen *T4* failed by rupture of one outer stud at midspan. Specimens *T5* and *T6* failed by rupture of all three studs at or between the loading rollers.

4. CONCENTRATED LOAD

The results are shown in table 13 and in figure 65 for wall specimens *BL–P1*, *P2*, and *P3*, loaded on the inside (plastered) faces, and in figure 66 for wall specimens *BL–P4*, *P5*, and *P6*, loaded on the outside (shingled) face.

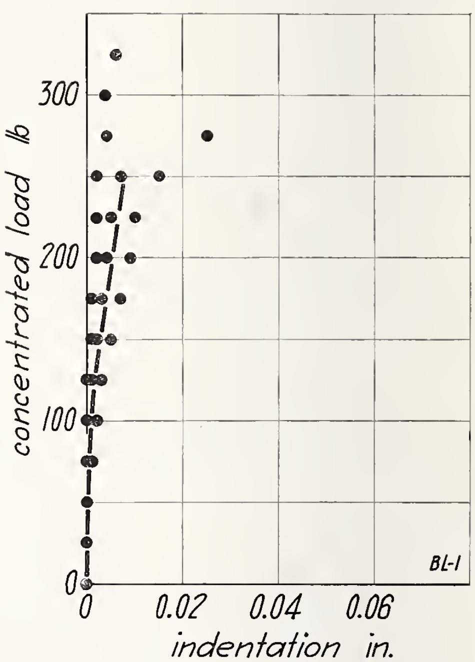

FIGURE 65.—*Concentrated load on wall BL, load applied to inside face.*

Load-indentation results for specimens *BL–P1*, *P2*, and *P3*.

The concentrated loads were applied to the inside face of specimens *P1*, *P2*, and *P3* on the plaster midway between two studs and 1½ to 2 ft from one end. On specimens *P2* and *P3* the load was applied over a lath joint. Each of the specimens failed by punching of the disk through the plaster and into the lath.

The concentrated loads were applied to the outside face of specimens *P4*, *P5*, and *P6* on a

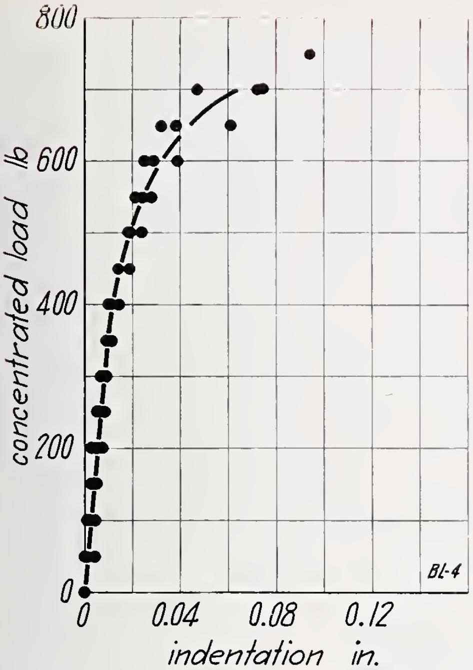

FIGURE 66.—*Concentrated load on wall BL, load applied to outside face.*

Load-indentation results for specimens *BL–P4*, *P5*, and *P6*.

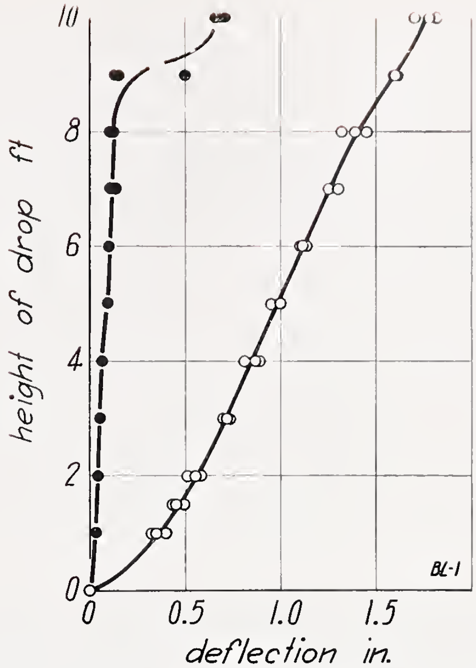

FIGURE 67.—*Impact load on wall BL, load applied to inside face.*

Height of drop-deflection (open circles) and height of drop-set (solid circles) results for specimens *BL–I1*, *I2*, and *I3* on the span 7 ft 6 in.

shingle 2¾ in. from the lower edge and about 2½ ft from one end of the specimen, midway between two furring strips and two studs. In specimen *P4* at a load of 650 lb and in specimen *P6* at a load of 700 lb the shingle split along the grain at one edge of the disk. At the maximum loads each of the specimens failed by punching of the disk through the shingles.

5. Impact Load

The results are shown in table 13 and in figure 67 for wall specimens *BL–I1*, *I2*, and *I3*, loaded on the inside face, and in figure 68 for wall specimens *BL–I4*, *I5*, and *I6*, loaded on the outside face.

The impact loads were applied to the center of the inside face of specimens *I1*, *I2*, and *I3*, the sandbag striking the plaster directly over the center stud. In each of the specimens *I1*, *I2*, and *I3* the plaster cracked longitudinally over either one or both outer studs at a drop of 1 ft, and at drops of 2.5, 3, and 2.5, respectively, the inside face of each specimen failed by sagging of the overhanging plaster edges. At drops of 3.5, 2, and 3 ft and deflections of

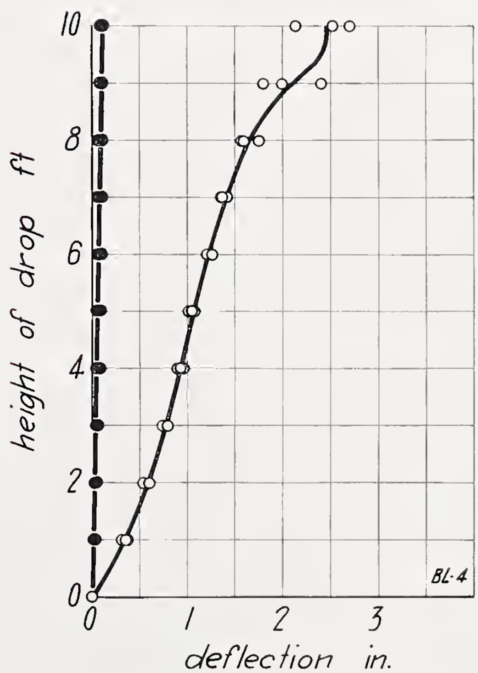

FIGURE 68.—*Impact load on wall BL, load applied to outside face.*

Height of drop-deflection (open circles) and height of drop-set (solid circles) results for specimens *BL–I4*, *I5*, and *I6* on the span 7 ft 6 in.

0.79, 0.69, and 0.72 in. in specimens *I1*, *I2*, and *I3*, respectively, the plaster cracked transversely across each specimen at a lath joint near midspan. The sets after a drop of 10 ft were 0.66, 0.71, and 0.68 in. in specimens *I1*, *I2*, and *I3*, respectively. Some of the furring strips were separated from the sheathing near midspan, but the outside face and the studs did not fail.

The impact loads were applied to the center of the outside face of specimens *I4*, *I5*, and *I6*, the sandbag striking the shingles directly over the center stud. In each of the specimens the plaster cracked transversely across each specimen at several places. The first cracks occurred at lath joints near midspan at drops of 3, 2.5, and 2.5 ft and deflections of 0.79, 0.69, and 0.65 in. in specimens *I4*, *I5*, and *I6*, respectively. At drops of 4, 4.5, and 4 ft, respectively, the inside (plastered) face of each specimen failed by opening of the cracks in the plaster. The sets after a drop of 10 ft were 0.12, 0.08, and 0.08 in. in specimens *I4*, *I5*, and *I6*, respectively. Most of the plaster had fallen, but the outside face and studs were undamaged.

6. Racking Load

Wall specimen *BL–R1* under racking load is shown in figure 69. The results for wall specimens *BL–R1*, *R2*, and *R3* are shown in table 13 and in figure 70.

The racking loads were applied to the top plate only and the stop was in contact with the floor plate only. In each of the specimens the plaster cracked in several places. Most of the

Figure 69.—*Wall specimen BL–R1 under racking load.*

cracks were parallel to a diagonal from the point of application of load to the stop. The first cracks occurred at loads of 1.125, 1.125, and 1.375 kips/ft and deformations of 0.49, 0.47, and 0.67 in./8 ft in specimens *R1*, *R2*, and *R3*, respectively. At a load of 1.50 kips/ft on specimens *R1* and *R2* some of the nails fastening the sheathing to the top plate pulled through the edges of the sheathing. At loads of 1.625, 1.375, and 1.592 (maximum) kips/ft on specimens *R1*, *R2*, and *R3*, respectively, there was noticeable vertical displacement between the two sheathing boards at the joint. At the maximum loads each of the specimens failed by the top plate pulling the nails from the studs and through the sheathing and lath.

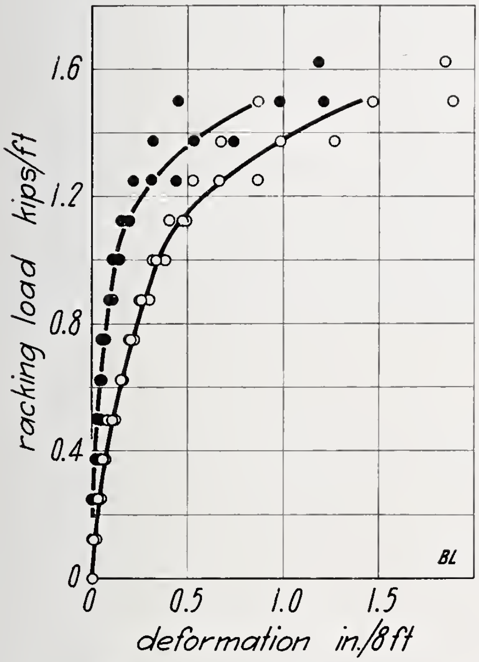

FIGURE 70.—*Racking load on wall BL.*

Load-deformation (open circles) and load-set (solid circles) results for specimens *BL–R1*, *R2*, and *R3*. The loads are in kips per foot of the face width of specimen (8 ft 0 in).

XI. PARTITION *BM*

1. Description, Sponsor's Statement

This construction was a wood frame with "Lok-Joint" lath and plaster on both faces. It was similar to wall constructions *BG*, *BJ*, and *BK*, with the exception that the top plate was single, not double, and both faces were lath and plaster, not one face.

The price in Washington, D. C., as of July 1937, was \$0.31/ft^2.

The partition specimens were 8 ft 0 in. high, 4 ft 0 in. wide, and 5⅝ in. thick. Each specimen consisted of a wood frame to which two like faces were fastened. The frame consisted of three studs, *A*, in figure 71, fastened to a floor

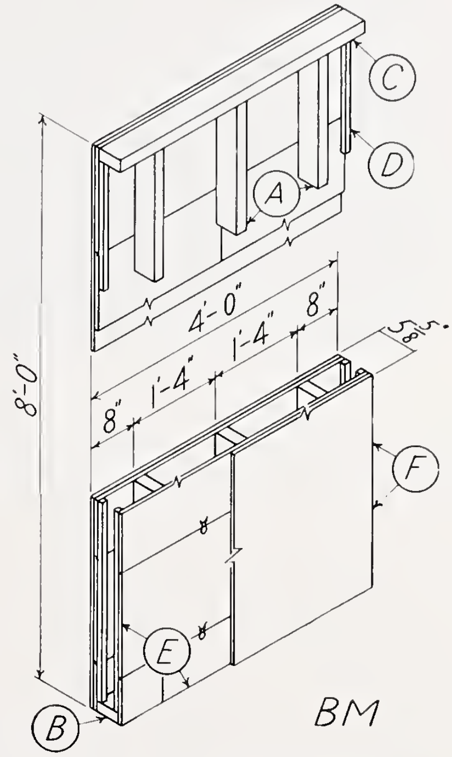

FIGURE 71.—*Partition specimen BM.*

A, stud; *B*, floor plate; *C*, top plate; *D*, nailing strip; *E*, lath; *F*, plaster.

plate, *B*, and a top plate, *C*, by nails. Both faces consisted of wood nailing strips, *D*, insulating-board lath, *E*, and plaster, *F*. The specimens were not painted.

Studs.—The studs, *A*, were red pine, 1⅝ by 3⅝ in. (nominal 2 by 4 in), 7 ft 8¾ in. long, spaced 1 ft 4 in. on centers. The studs were fastened to both plates by 16d common nails driven through the plates. There were two nails at each end of each stud.

Floor plate and top plate.—The plates, *B* and *C*, were red pine, 1⅝ by 3⅝ in. (nominal 2 by 4 in), 4 ft 0 in. long.

Nailing strips.—The nailing strips, *D*, were red pine, ¾ by ¾ in., 7 ft 8¾ in. long. In the specimen they supported the outer edges of the lath to facilitate plastering, but they are not used in a house.

Lath.—The lath, *E*, consisted of "Lok-Joint" lath, five full courses and one course cut to a height of 7⅜ in., as shown in figure 6. The plaster was applied to the burlap-textured surface. There was a vertical joint in each course, centered on a stud, with 3/16-in. clearance between the ends of the lath. The horizontal joints (shiplapped) were reinforced by "Loks," three at each joint. The lath was fastened to the studs, floor plate, top plate, and nailing strips by plasterboard nails spaced 4 in., about ½ in. from the edges of the lath.

Plaster.—The plaster, *F*, was ½ in. thick and consisted of a base coat and a finish coat. The lath was dry when the plaster was applied.

2. Impact Load

The results for partition specimens *BM–I1*, *I2*, and *I3* are shown in table 14 and in figure 72.

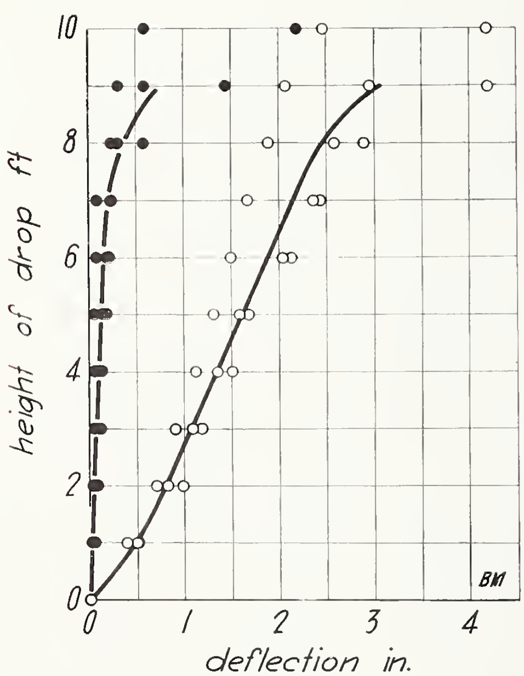

Figure 72.—*Impact load on partition BM.*

Height of drop-deflection (open circles) and height of drop-set (solid circles) results for specimens *BM–I1*, *I2*, and *I3* on the span 7 ft 6 in.

Table 14.—*Structural properties, partitions BM and BN*

Construction symbol	Weight	Load					
		Concentrated		Impact [a]			
		Specimen	Maximum load	Specimen	Failure of loaded face, height of drop	Failure of opposite face, height of drop	Maximum height of drop
	lb/ft²		*lb*		*ft*	*ft*	*ft*
BM	11.2	*P1*	167	*I1*	4.0	5.5	[b]10.0
		P2	253	*I2*	5.0	6.5	10.0
		P3	211	*I3*	4.5	6.0	10.0
Average			210		4.5	6.0	
BN	3.12	*P1*	149	*I1*	5.0	4.5	5.5
		P2	160	*I2*	8.0	8.0	8.5
		P3	157	*I3*	3.5	6.0	6.5
Average			155		5.5	6.2	6.8

[a] Span 7 ft 6 in.
[b] Test discontinued.

The impact loads were applied to the center of one face of each specimen, the sandbag striking the plaster directly over the center stud. In each of the specimens the plaster on both faces cracked longitudinally along the studs and transversely across each specimen in several places. The first transverse cracks in the face opposite the face struck occurred at lath joints near midspan at drops of 2, 1, and 1.5 ft and deflections of 0.70, 0.50, and 0.70 in. in specimens *I1*, *I2*, and *I3*, respectively. The first transverse cracks in the face struck occurred at lath joints near midspan at a drop of 3 ft and deflections of 0.90, 1.08, and 1.18 in. in specimens *I1*, *I2*, and *I3*, respectively. At drops of 4, 5, and 4.5 ft, on specimens *I1*, *I2*, and *I3*, respectively, the face struck by the sandbag failed owing to rupture of the plaster at midspan, especially at the point of impact. At drops of 5.5, 6.5, and 6 ft on specimens *I1*, *I2*, and *I3*, respectively, the face opposite that struck by the sandbag failed by falling of some of the plaster. In each of the specimens the center stud broke at midspan at drops of 10, 9, and 10 ft, respectively. Specimen *I2* failed structurally at a drop of 10 ft by the sandbag passing through the specimen.

3. Concentrated Load

Partition specimen *BM–P2* under concentrated load is shown in figure 73. The results for partition specimens *BM–P1*, *P2*, and *P3* are shown in table 14 and in figure 74.

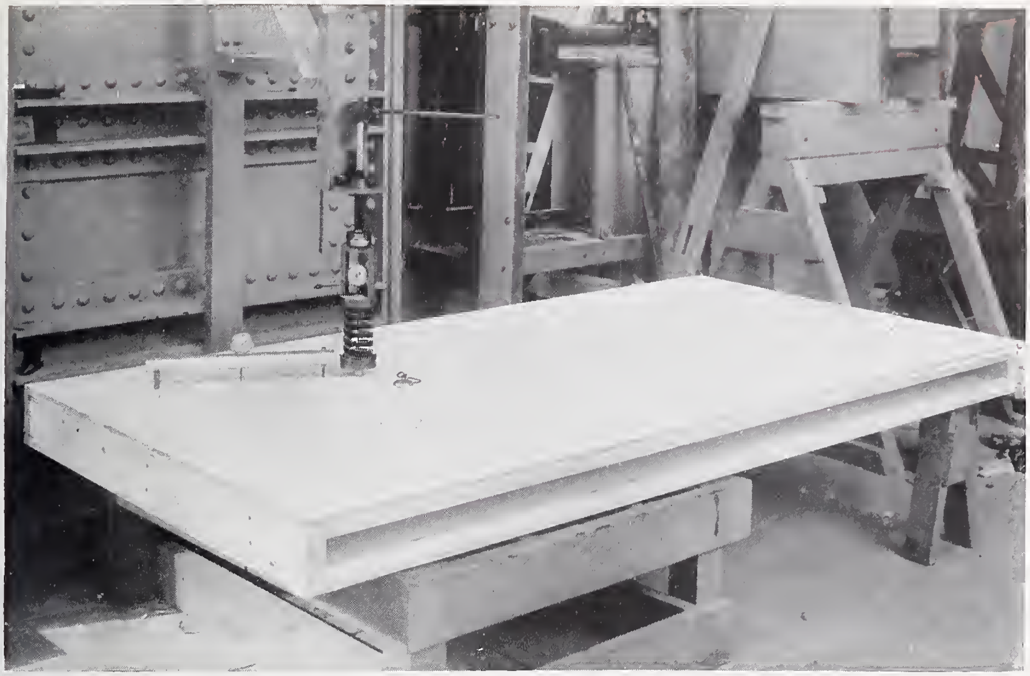

FIGURE 73.—*Partition specimen BM–P2 under concentrated load.*

The concentrated loads were applied to one face of each specimen on the plaster midway between two studs over a lath joint 1½ to 2 ft from one end of the specimen. Each of the specimens failed by punching of the disk through the plaster and by the spreading of the lath at the joint.

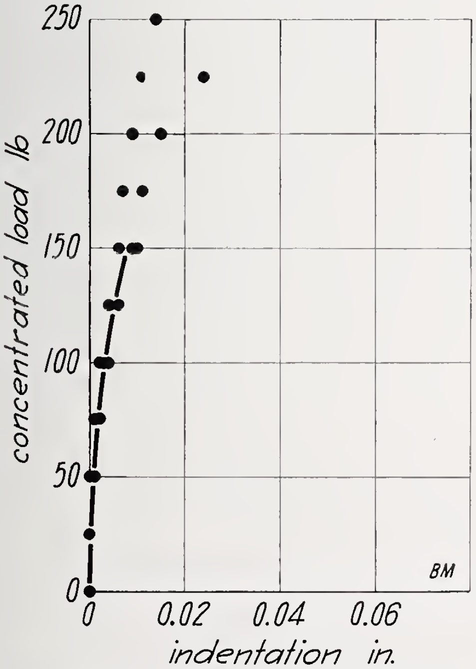

FIGURE 74.—*Concentrated load on partition BM.*

Load-indentation results for specimens *BM-P1, P2,* and *P3.*

XII. PARTITION *BN*

1. DESCRIPTION, SPONSOR'S STATEMENT

This construction was a wood frame with ½-in. "Graylite" interior board on both faces. It was similar to wall construction *BI*, with the exception that the top plate was single, not double, and both faces were interior board, not one face. It was similar to wall construction *BH*, with the exception that the top plate was single, not double, both faces were interior board, not one face, and the interior board was ½ in. thick, not ¾ in.

The price of this construction in Washington, D. C., as of July 1937, was $0.18/ft^2.

The partition specimens were 8 ft 0 in. high, 4 ft 0 in. wide, and 4⅝ in. thick. Each specimen consisted of a wood frame to which two like interior board faces were fastened.

The frame consisted of three studs, *A*, shown in figure 75, fastened to a floor plate, *B*, and a top plate, *C*, by nails. Both faces consisted of interior board, D, with a vertical joint at midwidth covered by a batten strip, E. The specimens were not painted.

Studs.—The studs, A, were red pine, 1⅝ by 3⅝ in. (nominal 2 by 4 in), 7 ft 8¾ in. long, spaced 1 ft 4 in. on centers. The studs were fastened to both plates by 16d common nails driven through the plates. There were two nails at each end of each stud.

Floor plate and top plate.—The plates, B and C, were red pine, 1⅝ by 3⅝ in. (nominal 2 by 4 in), 4 ft 0 in. long.

Interior board.—The interior board, D, was four "Graylite" boards, 1 ft 11¹⁵⁄₁₆ in. by ½ in., 8 ft 0 in. long, with the linen-textured surface exposed. There was a vertical joint on the center stud with ⅛-in. clearance between the edges of the boards on each face. The interior board was fastened to the center stud, floor plate, and top plate by 4d galvanized roofing nails spaced 3 in., about ½ in. from the edges of the board, and to the outer studs by 4d finishing nails spaced 6 in., driven at an angle, adjacent nails being inclined in opposite directions.

Batten strips.—The batten strips, E, were two pieces of "Graylite" interior board, ½ by 2½ in., 8 ft 0 in. long, with beveled outer edges. The batten strips covered the vertical joints at midwidth on each face of the specimen and were each fastened to the center stud by two rows of 4d finishing nails spaced 3 in., driven through the bevel edges, through the interior board and into the center stud.

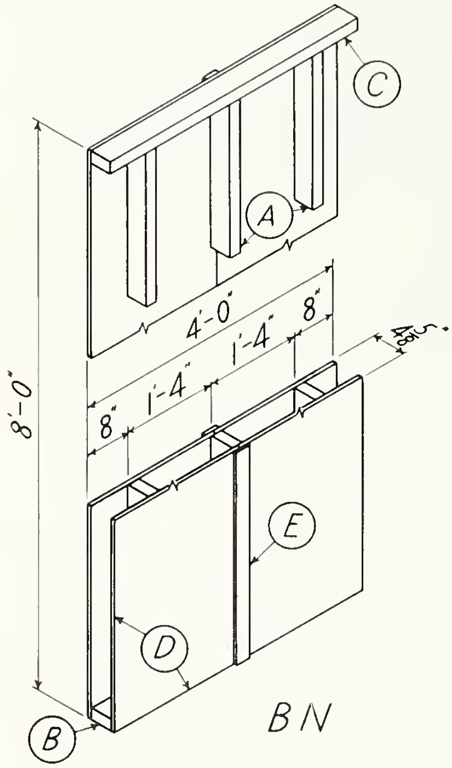

Figure 75.—*Partition specimen BN.*

A, stud; B, floor plate; C, top plate; D, interior board; E, batten strip.

2. Impact Load

Partition specimen *BN–I2*, during the impact test, is shown in figure 76. The results for partition specimens *BN–I1*, *I2*, and *I3* are shown in table 14 and in figure 77.

The impact loads were applied to the center of one face of each specimen, the sandbag striking the batten strip and the interior board directly over the center stud. In each of the specimens the interior board on the face opposite the face struck separated from the studs at drops of 4, 7, and 6 ft on specimens *I1*, *I2*, and *I3*, respectively, and these faces failed by rupture of the interior board at midspan transversely across each specimen at drops of 4.5, 8, and 6 ft, respectively. At drops of 5, 8, and 3.5 ft, respectively, the face struck failed by rupture of the interior board where the sandbag struck. At drops of 4.5, 7.5, and 6 ft, respectively, the center stud of each specimen ruptured at midspan. At the maximum height of drop, each specimen failed by the sandbag passing through the specimen.

3. Concentrated Load

The results for partition specimens *BN–P1*, *P2*, and *P3* are shown in table 14 and in figure 78.

The concentrated loads were applied to one face of each specimen on the interior board midway between two studs and about 1½ ft from one end of the specimen. Each of the specimens failed by punching of the disk through the interior board.

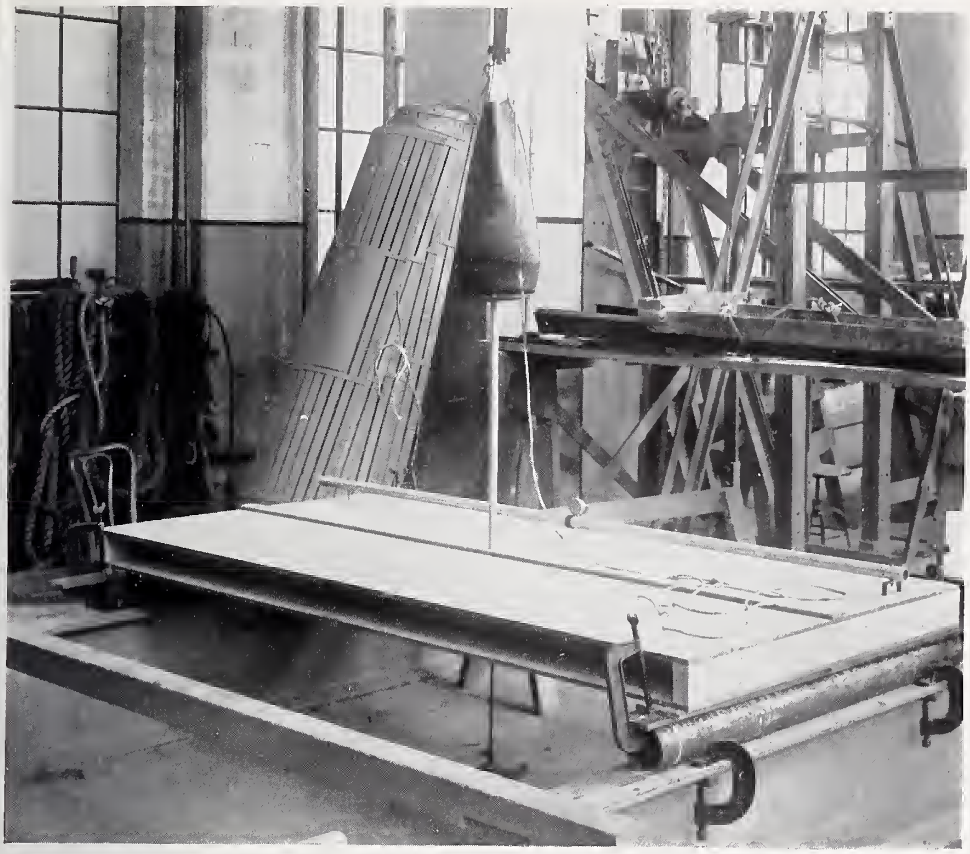

FIGURE 76.—*Partition specimen BN–I2 during the impact test.*

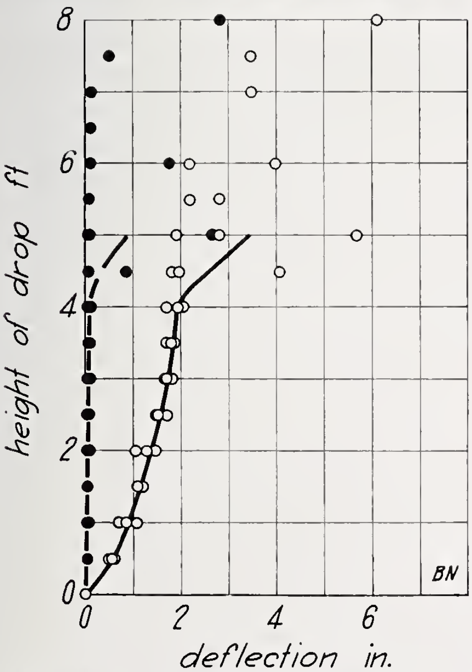

FIGURE 77.—*Impact load on partition BN.*

Height of drop-deflection (open circles) and height of drop-set (solid circles) results for specimens *BN-I1*, *I2*, and *I3* on the span 7 ft 6 in.

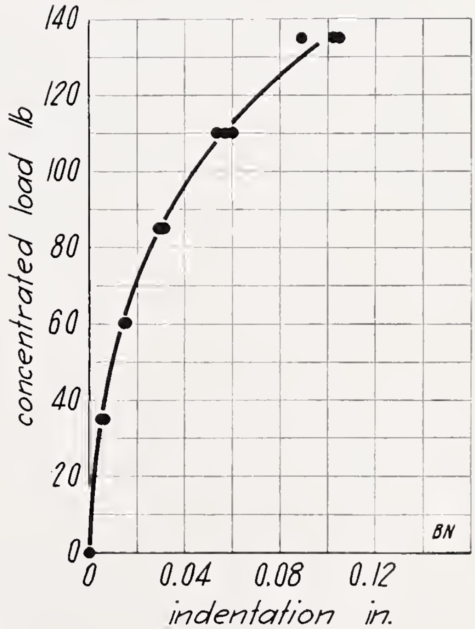

FIGURE 78.—*Concentrated load on partition BN.*

Load-indentation results for specimens *BN-P1*, *P2*, and *P3*.

XIII. SPONSOR'S COMMENTS

Basically, an "Insulite" wall consists of a wood frame with "Bildrite" sheathing on the outside and either "Graylite" interior board or "Lok-Joint" lath and plaster on the inside.

These Insulite products are the results of more than 25 years' experience with structural wood-fiber insulating board, including research in the laboratory and studies of its use in buildings. These may be combined in different ways with many outside finishing materials to meet the requirements of different codes, purposes, and geographic locations.

The application of these building materials is simple and rapid.

Many dealers in building materials in both the United States and Canada stock these materials in well-protected packages. Each package contains complete directions for the application of the material.

The physical properties of the insulating board were determined by the Paper Section, under the supervision of B. W. Scribner, with the assistance of S. G. Weissberg. The physical properties of the plaster were determined by the Lime and Gypsum Section, under the supervision of L. S. Wells, with the assistance of W. F. Clarke. The physical properties of the materials for the stucco and the brick veneer were determined by the Masonry Construction Section, under the supervision of D. E. Parsons, with the assistance of C. C. Fishburn and P. H. Petersen.

The description and drawings of the specimens were prepared by E. J. Schell and G. W. Shaw of the Building Practice and Specifications Section, under the supervision of V. B. Phelan, from the information supplied by the sponsor and from the specimens.

The structural properties were determined by the Engineering Mechanics Section, under the supervision of H. L. Whittemore and A. H. Stang, with the assistance of the following members of the professional staff: F. Cardile, R. C. Carter, H. Dollar, M. Dubin, A. H. Easton, A. S. Endler, M. Greenspan, C. D. Johnson, L. Karpeles, A. J. Sussman, and L. R. Sweetman.

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WASHINGTON, May 2, 1939.

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