U. S. DEPARTMENT OF COMMERCE

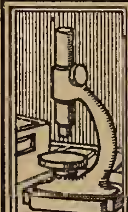
BUILDING MATERIALS AND STRUCTURES

REPORT BMS18

Structural Properties of "Pre-Fab" Constructions for Walls, Partitions, and Floors Sponsored by the Harnischfeger Corporation

by

HERBERT L. WHITTEMORE
AMBROSE H. STANG, *and*
VINCENT B. PHELAN



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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. Practically all of these constructions were sponsored by groups within the building industry which advocate and promote the use of such constructions and which have built and submitted representative specimens as outlined in report BMS2, Methods of Determining the Structural Properties of Low-Cost House Constructions. The sponsor is responsible for the representative character of the specimens and for the detailed description given in each report. The Bureau is responsible for the accuracy of the test data.

This report covers only the load-deformation relations and strength of the structural elements submitted when subjected to compressive, transverse, concentrated, impact, and racking loads by standardized methods simulating the loads to which the elements would be subjected in actual service. It may be feasible to determine later 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 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.*

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ABSTRACT

For the program on the determination of the structural properties of low-cost house constructions, the Harnischfeger Corporation submitted 33 specimens representing their "Pre-Fab" constructions for walls, partitions, and floors.

The wall specimens were subjected to compressive, transverse, concentrated, impact, and racking loads; the partition specimens to impact and concentrated loads; and the floor specimens to transverse, concentrated, and impact 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 concentrated-load tests being made on undamaged portions of the specimens used for the transverse or impact tests. The deformation under load and the set after the load was removed were measured for uniform increments of load up to the maximum load, except for concentrated loads, for which the set only was determined. The results are presented graphically 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,[1] and that part of the program relating to structural properties in

[1] Price 10 cents. See cover page II.

report BMS2, Methods of Determining the Structural Properties of Low-Cost House Constructions.[2]

As a part of the research on structural properties, six masonry wall constructions have been subjected to a series of standardized laboratory tests to provide data on the properties of some constructions for which the behavior in service is generally known. These data are given in report BMS5, Structural Properties of Six Masonry Wall Constructions.[3] Similar tests have been made on wood-frame constructions by the Forest Products Laboratory of the United States Department of Agriculture, the results of which will be given in a subsequent report in this series.

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 the partition, and concentrated loads by furniture or by a ladder or other object leaning against the partition. Transverse loads are applied to floors by furniture and by the occupants; concentrated loads by furniture, for example, the legs of a piano; and impact loads by objects falling on the floor or by persons jumping on the floor.

The deformation and set under each increment of load were measured because the suitability of a wall, partition, or floor construction depends in part on its resistance to deformation under load, and whether it returns to its original size and shape when the load is removed.

[2] Price 10 cents.
[3] Price 15 cents.

II. SPONSOR AND PRODUCT

The specimens were submitted by the Harnischfeger Corporation, Milwaukee, Wis., and represented constructions marketed under the trade name "Pre-Fab Homes." These constructions consisted of prefabricated panels with welded sheet-steel frames for walls, partitions, and floors, designed to be erected on masonry foundations, and interlocked by special key-and-tapered-pin fastenings.

III. SPECIMENS AND TESTS

The specimens represented three elements of a house which were assigned the following symbols: Wall, *AZ;* partition, *BA;* and floors, *BB* and *BC.* The specimens were assigned designations in accordance with table 1.

TABLE 1.—*Specimen designations*

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

[a]These specimens were undamaged portions of the specimens used for the transverse or impact tests.

The specimens were tested in accordance with BMS2, Methods of Determining the Structural Properties of Low-Cost House Constructions,[4] which also gives the requirements for the specimens and describes the presentation of the results of the tests, particularly the load-deformation graphs.

The tests were begun April 18, 1938, and completed April 25, 1938. The sponsor's representative witnessed the tests.

IV. WALL *AZ*

1. SPONSOR'S STATEMENT

(a) *Materials*

Steel.—Copper-bearing sheets, hot-rolled, annealed, and pickled. The chemical composition

[4] Price 10 cents.

of the steel is given in table 2 and the mechanical properties in table 3. Granite City Steel Co.

TABLE 2.—*Chemical composition of the steel*

Element	Content		
	Actual	Specified minimum	Specified maximum
	Percent	*Percent*	*Percent*
Carbon	0.17	0.15	0.25
Manganese	.37	.35	.48
Phosphorus	.011		.008
Sulfur	.031		.044
Copper	.31	.20	

TABLE 3.—*Mechanical properties of the steel*

Direction	Yield point	Tensile strength	Elongation in 8 in.
	lb/in.^{2}	*lb/in.*^{2}	*Percent*
In direction of rolling	43,450	60,400	21.2
Across direction of rolling	43,350	63,950	20.1

The steel was prepared for paint by cleaning in a high-pressure-spray washing machine. The cleaning solution was sulfonated naphthalene, sodium orthophosphate, and sodium chromate in an aqueous solution maintained at 200° F.

Welds.—Electric-arc welds made with mild-steel electrodes and a shielded arc. P & H "Hansen" arc welder, d-c rotary type.

Paint.—Priming, rust-resisting, red. The formula for the paint is given in table 4. Pittsburgh Plate Glass Co.

TABLE 4.—*Formula for the paint*

Paint		Pigment		Vehicle [a]	
Ingredient	Content	Ingredient	Content	Ingredient	Content
	Percent		*Percent*		*Percent*
Pigment	30	Zinc chromate	30	Nonvolatile	44
Vehicle	70	Iron oxide	50	Volatile	56
		Inert (asbestine and silica)	20		
	100		100		100

[a] Alkyde type, 45 percent linseed oil modified synthetic resin.

Insulating board.—Wood-fiber, 1/2 in. thick, sized to decrease the moisture absorption; modulus of rupture, 1,090 lb/in.^{2}; tensile strength, 646 lb/in.^{2}; density (at 20-percent humidity), 25.0 lb/ft^3; thermal conductance (0.5 in. thickness), 0.77 Btu/hr ft^2 °F; absorption, 48-hr immersion, 25.2 percent by weight. The air infiltration through the insulating board is given in table 5 and the linear expansion in table 6. Homasote Co.'s "Homasote"

TABLE 5.—*Air infiltration through the insulating board*

Wind velocity (mph)	Air infiltration	Wind velocity (mph)	Air infiltration
	ft^3*/hr/ft*^{2}		*ft*^{3}*/hr/ft*^{2}
20	0.1	80	4.3
40	.5	100	7.7
60	1.9		

TABLE 6.—*Linear expansion of the insulating board*

Relative-humidity range (percent)	Linear expansion	Relative-humidity range (percent)	Linear expansion
	Percent		*Percent*
20 to 60	0.30	20 to 85	0.45
20 to 70	.33	20 to 95	.50

Plywood.—Five-ply, Douglas fir, 1/2 in. thick, hot-press phenol-resin bonded; modulus of rupture, 8,500 lb/in.^{2} The linear expansion of the plywood is given in table 7. Harbor Plywood Corporation's "Super Harboard."

TABLE 7.—*Linear expansion of the plywood*

Relative-humidity range (percent)	Linear expansion	Relative-humidity range (percent)	Linear expansion
	Percent		*Percent*
25 to 60	0.06	25 to 100	0.15
25 to 90	.12		

Three-ply, Douglas fir, 5/16 in. thick, bonded with water-resistant glue. Weyerhaeuser Sales Corporation.

Paper.

Sheathing, felt-paper base, saturated with high-melting tar (above 180° F); weight, 30 lb/500 ft^2. The Barrett Co.'s "Slaters Felt."

Kraft, duplex, moisture-resistant, consisting of two sheets of 30-lb Kraft paper (basis 24 by 36 in.; 480 sheets) cemented with asphalt; 36 in. wide; weight, 38.2 lb/1,000 ft^2. Rexford Paper Co.'s "Vapor Shields."

Shingles.—Red cedar, No. 1, 18 in. long, five butts to 2¼ in., stained white. The Edham Co., Inc.

Shingle stain.—White. Weyerhaeuser Sales Corporation

Screws.

Wood, 1½ in., No. 10 (0.190-in. diam), 13 threads per in., flat head, made from SAE 1015 steel, not heat-treated, plated with cadmium. Rockford Screw Products Co.

Self-tapping, ¾ in., No. 8 (0.164-in. diam), 15 threads per in., flat head, made from SAE 1015 steel, hardened, "Parkerized." Rockford Screw Products Co.'s "Type *A*."

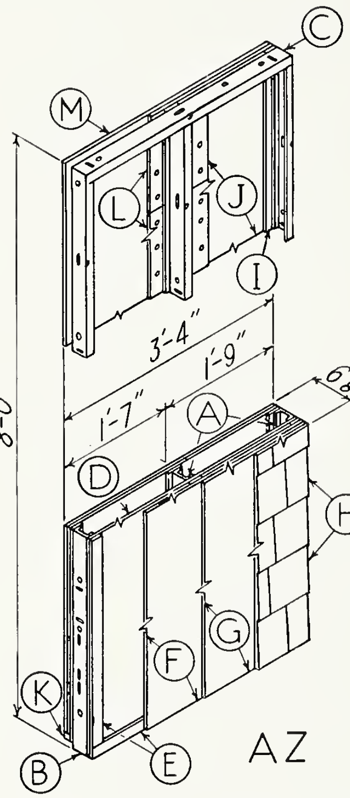

FIGURE 1.—*Three-foot four-inch wall specimen AZ.*

A, stud; *B*, sill; *C*, wall plate; *D*, insulation; *E*, furring strip; *F*, sheathing; *G*, sheathing paper; *H*, shingle siding; *I*, furring strip; *J*, moisture barrier; *K*, ground; *L*, lath; *M*, plaster.

Nails.

Shingle, 3d, 1¼ in. long, No. 13 gage (0.0915-in. diam), zinc coated.

Berry-box, ¾ in. long, No. 17 gage (0.0540-in. diam).

Wood ground.—Western white pine, S4S (surfaced four sides).

Lath.—Gypsum, 40 by 16 by ⅜ in. United States Gypsum Co.'s "Perforated Rocklath."

Plaster.

Base coat, 2 parts sanded plaster and 1 part wood-fibered plaster, by volume. The sanded plaster was United States Gypsum Co.'s "Red Top Sanded Plaster" containing approximately 1 part neat gypsum plaster and 2 parts dry sand, by weight. The wood-fibered plaster was Grand Rapids Plaster Co.'s "Climax."

Finish coat, 1 part water to 2 parts prepared gypsum plaster, by volume. The prepared gypsum plaster was United States Gypsum Co.'s "Red Top Sand Float Finish."

(*b*) *Description*

(1) *Three-foot four-inch wall specimens.*—The 3-ft 4-in. wall specimens were 8 ft 0 in. high, 3 ft 4 in. wide, and 6⅜ in. thick. Each specimen consisted of a welded sheet-steel frame to which the faces were fastened. The frame consisted of three sheet-steel studs, *A*, shown in figures 1 and 2, fastened to a sheet-steel sill, *B*, and a sheet-steel wall plate, *C*, by welds, and covered with one coat of paint applied by spraying. The outside face was a double wall, consisting of insulation, *D*, furring strips, *E*, and sheathing, *F*, fastened to the frame by wood screws and covered by sheathing paper, *G*, and wood-shingle siding, *H*. The inside face consisted of furring strips, *I;* moisture barrier, *J;* wood ground, *K;* gypsum lath, *L;* and plaster, *M*.

The price of this construction in Washington, D. C., as of July 1937 was $0.41/ft².

Studs.—The studs, *A*, were channels, 3 by 1¼ in., 8 ft 0 in. long, formed from sheet steel, No. 15 U. S. Std. Gage (0.0689 in. thick). The studs were crimped at each end to fit between the flanges of the sill and the wall plate. The web of each stud had seven vertical and four horizontal slots, 1¹⁄₁₆ by ³⁄₁₆ in., along the centerline for key-and-pin fastenings to adjacent panels, and seven ⅞-in. holes for conduits. There were ½-in. holes in both flanges opposite five of the vertical slots to provide for the insertion of the pins into the keys. The inside flange of each outer stud had two reinforcement plates, 1½ by 1 by ¼ in.,

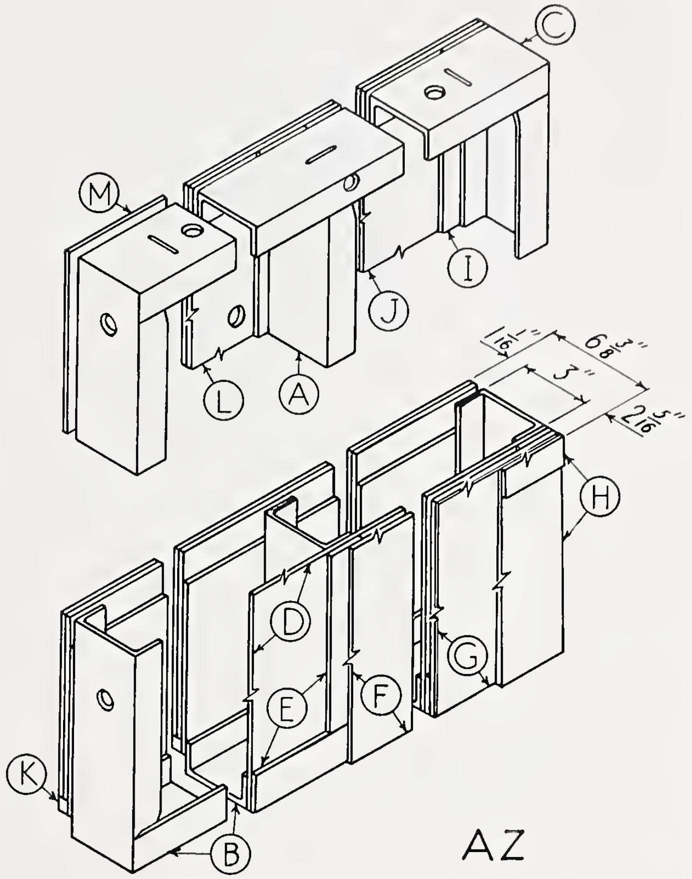

FIGURE 2.—*Details of wall specimen AZ.*

A, stud; *B*, sill; *C*, wall plate; *D*, insulation; *E*, furring strip; *F*, sheathing; *G*, sheathing paper; *H*, shingle siding; *I*, furring strip; *J*, moisture barrier; *K*, ground; *L*, lath; *M*, plaster.

fastened to the inside of the flange near the lower end by welds. There was one $\frac{3}{8}$-in. tapped hole through each plate and flange for bolt connections to a floor panel.

Sill.—The sill, *B*, was 3 ft $3\frac{3}{8}$ in. long and identical in section with the studs, *A*. The web had two transverse and one longitudinal slot, $1\frac{1}{16}$ by $\frac{3}{16}$ in., and three $\frac{7}{8}$-in. holes. Each flange had a $\frac{1}{2}$-in. hole opposite the longitudinal slot.

Wall plate.—The wall plate, *C*, was the same as the sill, *B*

Insulation.—The insulation, *D*, was one piece of insulating board, 8 ft 0 in. by 3 ft $3\frac{3}{8}$ in. by $\frac{1}{2}$ in., fastened to the flanges of the studs, sill, and wall plate by wood screws, spaced 9 in. on centers. The heads of the screws were on the inside of the flanges and the screws extended through the insulation and the furring strips, into the sheathing.

Furring strips.—The furring strips, *E*, were strips of insulating board, $1\frac{1}{2}$ by $\frac{1}{2}$ in., fastened to the insulation by berry-box nails, spaced 9 in. on centers. There were three vertical strips, one over each stud, and two horizontal strips, one at each end of the specimen.

Sheathing.—The sheathing, *F*, was one piece of 5-ply plywood, 8 ft 0 in. by 3 ft $3\frac{3}{8}$ in. by $\frac{1}{2}$ in.

Sheathing paper.—The sheathing was covered with one layer of sheathing paper, *G*, 8 ft 0 in. by 3 ft $3\frac{3}{8}$ in., fastened to the plywood by the nails fastening the shingles.

Shingle siding.—The shingles, *H*, were laid 8 in. to the weather and fastened to the sheathing by shingle nails, four per shingle.

Furring strips.—The furring strips, *I*, were 3-ply plywood, $\frac{5}{16}$ in. thick, fastened to the inside flanges of the studs, sill, and wall plate by self-tapping screws, spaced 9 in. on centers. There were two horizontal and three vertical furring strips. The horizontal strips were 7 in. wide and were fastened to the lower end of the specimen. The lower edge of the bottom strip was ¾ in. above the bottom of the sill, and in a house it would separate the frame of the floor panel from the frame of the wall panel. The next strip was 1½ in. above the bottom strip and in a house would provide for fastening the baseboard. The vertical strips were 2 in. wide and extended from the horizontal strips to the upper end of the specimen, one along each stud, and were fastened so that one edge was on the flange, 15/32 in. from the web, and the other edge extended beyond the edge of the flange.

Moisture barrier.—The moisture barrier, *J*, was one sheet of Kraft moisture-resistant paper, 8 ft 0 in. by 3 ft 3⅞ in., fastened by the nails which fastened the lath.

Ground.—The ground, *K*, was a wood strip, ¾ by ¾ in., 3 ft 4 in. long, fastened to the bottom furring strip, *I*, by shingle nails, spaced 11 in. on centers. The lower edge was flush with the lower edge of the furring strip.

Lath.—The lath, *L*, was 5 pieces of gypsum lath, 40 by 16 by ⅜ in., and 1 piece, 40 by 14½ by ⅜ in., fastened to the furring strips, *I*, by shingle nails, spaced 4 in. on centers.

Plaster.—The plaster, *M*, was ⅝ in. thick and consisted of a base coat and a finish coat.

(2) *Six-foot eight-inch wall specimens.*—The 6-ft 8-in. wall specimens were 8 ft 0 in. high, 6 ft 8 in. wide, and 6⅜ in. thick. Each specimen consisted of two panels, identical with the 3-ft 4-in. specimens, interlocked by four key-and-pin fastenings. The method of interlocking the studs of adjacent panels is shown in figure 3. The keys were made of sheet steel, No. 7 U. S. Std. Gage (0.1838 in. thick), cadmium plated. The tapered pins were made of sheet steel, No. 11 U. S. Std. Gage (0.1225 in. thick), cadmium plated.

(*c*) *Comments*

The wall panels are fabricated at the factory in standard widths of 1 ft 8 in. and 3 ft 4 in. and a height of 9 ft 413/16 in. The double wall, consisting of insulation, furring strips, and sheathing, is attached at the factory as are also the furring strips for the inside face. The inside and outside finishes are applied after erection.

The panels are designed to be erected on a masonry wall foundation. Insulating-board strips, 5½ by ½ in., impregnated with asphalt, are laid on top of the foundation walls to form a bearing for the floor and wall panels. The wall panels are fastened to the floor panels by bolts and to adjacent wall panels by the key-and-pin fastenings shown in figure 3. Corners are made with a corner panel fastened by key-and-pin fastenings to the wall panels. Panels

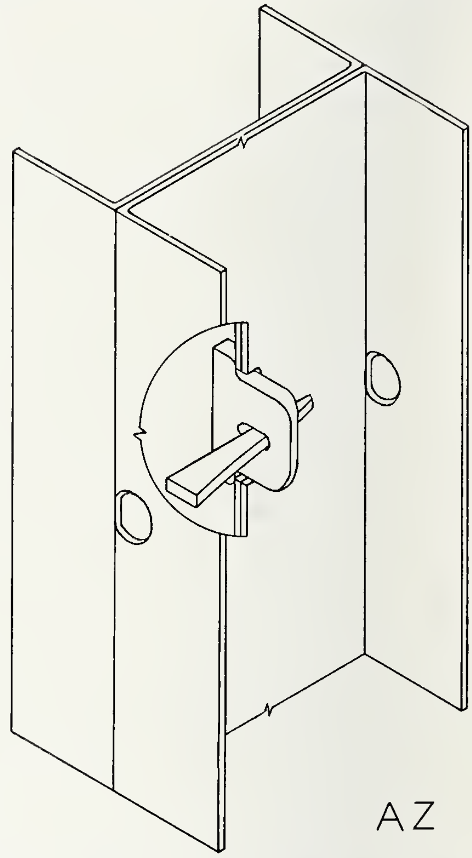

Figure 3.—*Method of interlocking wall panels with key-and-pin fastenings*

for second-story walls rest on sheet-steel brackets, which support the second floor, and are fastened to the first-story panels by key-and-pin fastenings. Doors and windows are installed in panels at the factory.

The outside finish may be paint, wood shingles or lap siding, composition shingles, stucco, or brick veneer. The inside is usually finished with plaster on gypsum lath.

2. Compressive Load

Wall specimen *AZ-C2* under compressive load is shown in figure 4. The results for wall specimens *AZ–C1*, *C2*, and *C3* are shown in table 8 and in figures 5 and 6.

TABLE 8.—*Structural properties of wall AZ*

[Weight, 10.6 lb/ft²]

Load	Load applied	Specimen designation	Failure of loaded face, height of drop	Failure of opposite face, height of drop	Maximum height of drop	Maximum load
			ft	*ft*	*ft*	[b]*Kips/ft*
Compressive	Upper end, 2.06 in. from the inside face.[a]	*C1*				8.63
		C2				9.88
		C3				8.76
	Average					9.09
						lb/ft²
Transverse	Inside face; span, 7 ft 6 in.	*T1*				174
		T2				170
		T3				168
	Average					171
Do	Outside face; span, 7 ft 6 in.	*T4*				176
		T5				180
		T6				181
	Average					179
						lb
Concentrated	Inside face	*P1*				328
		P2				369
		P3				400
	Average					366
Do	Outside face	*P4*				[c] 1,000
		P5				[c] 1,000
		P6				[c] 1,000
	Average					[c] 1,000
Impact	Inside face; span, 7 ft 6 in.	*I1*	3.5	9.0	[d]10.0	
		I2	3.5	7.5	[d]10.0	
		I3	4.0	9.5	[d]10.0	
	Average		3.7	8.7	[d]10.0	
Do	Outside face; span, 7 ft 6 in.	*I4*	8.0	3.0	[d]10.0	
		I5	9.0	5.5	[d]10.0	
		I6	8.5	3.5	[d]10.0	
	Average		8.5	4.0	[d]10.0	
						[b]*Kips/ft*
Racking	Near upper end	*R1*				1.20
		R2				1.50
		R3				1.23
	Average					1.31

[a] For the compressive load the thickness of the specimens was taken as 3 in., that of the structural portion only.
[b] A kip is 1,000 lb.
[c] Specimen did not fail. Test discontinued.
[d] Test discontinued.

For determining the eccentricity of loading in the compressive test, the thickness of the specimens was taken as the thickness of the studs, and the compressive loads were applied one-third the thickness of the studs from the inside edge of the studs. The shortenings and sets shown in figure 5 for a height of 8 ft were computed from the values obtained from the compressometer readings. The gage length of the compressometers was 7 ft 6 in. The lateral deflections shown in figure 6 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. For compressive loads up to about 5 kips/ft the specimens deflected toward the inside face, because the stiffness of the inside face more than offset the effect of the eccentric loading. For loads greater than 5 kips/ft the specimens deflected in the opposite direction, that is, toward the outside face, possibly because of progressive local failure of the inside face.

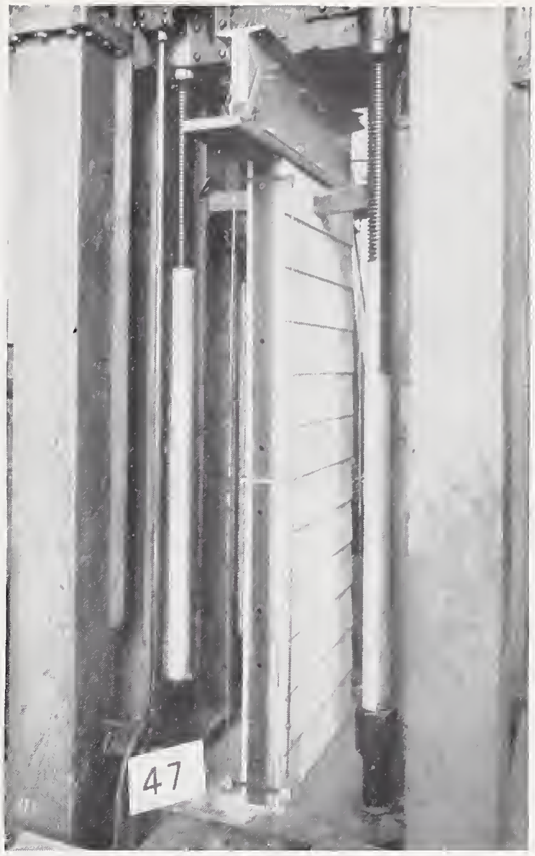

FIGURE 4.—*Wall specimen AZ–C2 under compressive load*

Each of the specimens failed by buckling of one or more studs near midheight. In each case the buckling occurred at holes in the flanges of the studs. For specimen *C1* the plaster and lath separated from the lower end of the specimen.

3. TRANSVERSE LOAD

The results are shown in table 8 and in figure 7 for wall specimens *AZ–T1*, *T2*, and *T3*, loaded

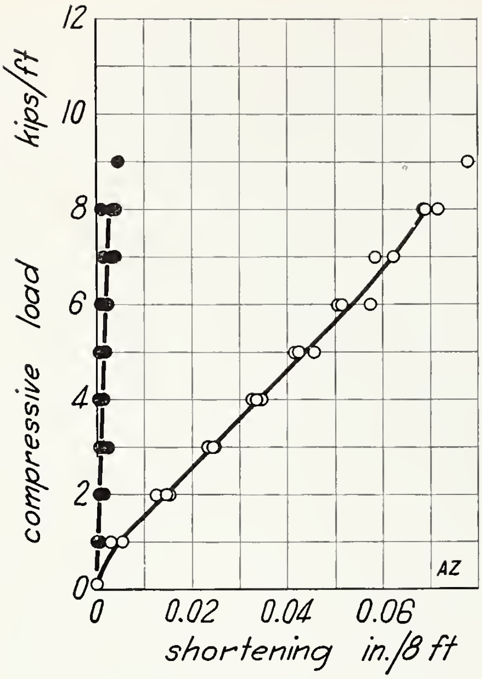

FIGURE 5.—*Compressive load on wall AZ.*

Load-shortening (open circles) and load-set (solid circles) results for specimens *AZ–C1*, *C2*, and *C3*. The load was applied 2.06 inches from the inside face. The loads are in kips per foot of actual width of specimen.

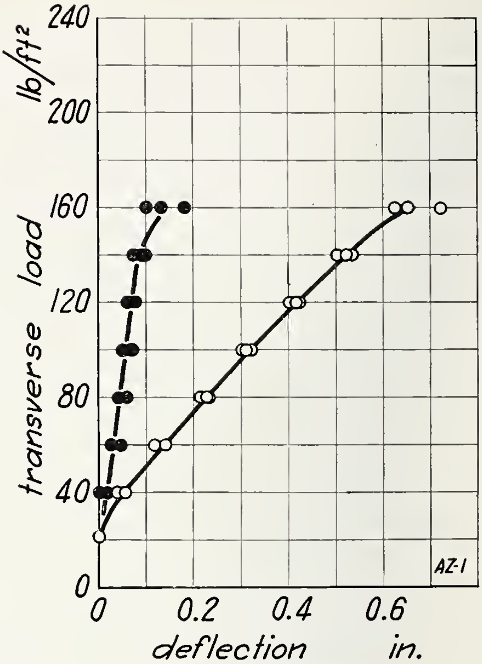

FIGURE 7.—*Transverse load on wall AZ, load applied to inside face.*

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

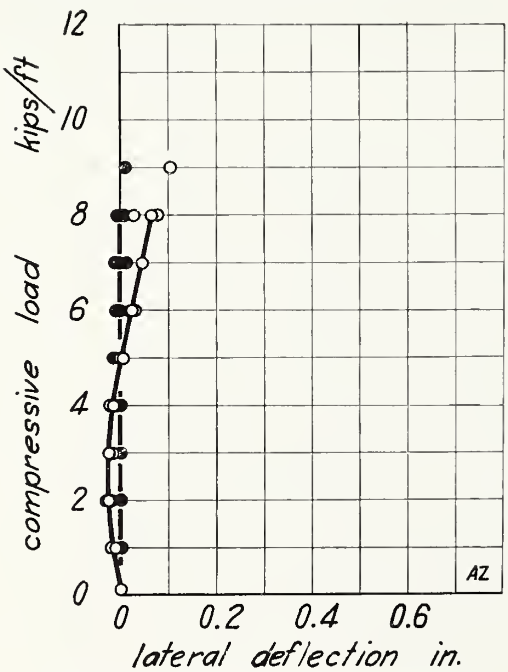

FIGURE 6.—*Compressive load on wall AZ.*

Load-lateral deflection (open circles) and load-lateral set (solid circles) results for specimens *AZ–C1*, *C2*, and *C3*. The load was applied 2.06 inches from the inside face. The loads are in kips per foot of actual width of specimen. The deflections and sets are for a gage length of 7 ft 4 in., the gage length of the deflectometers.

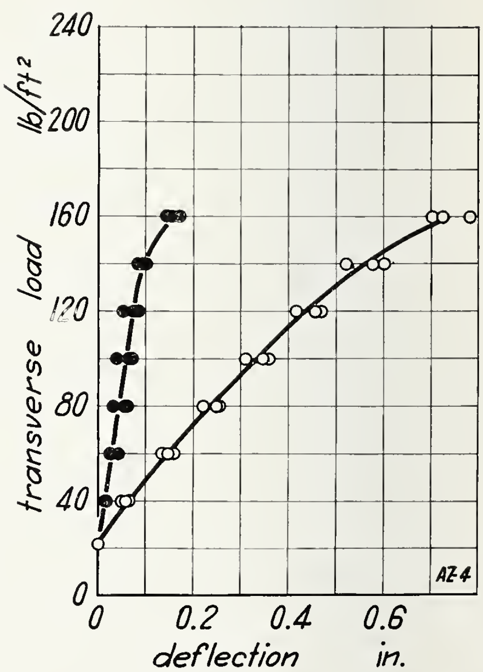

FIGURE 8.—*Transverse load on wall AZ, load applied to outside face.*

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

on the inside face, and in figure 8 for wall specimens *AZ–T4*, *T5*, and *T6*, loaded on the outside face.

Each of the specimens *T1*, *T2*, and *T3* failed by buckling of the studs near midspan at holes in the flanges of the studs.

For each of the specmens *T4*, *T5*, and *T6* the plaster cracked transversely across the specimen in two or more places between the loading rollers. The first cracks occurred at loads of 110, 160, and 160 lb/ft² and deflections of 0.41, 0.72, and 0.70 in. for specimens *T4*, *T5*, and *T6*, respectively. Each of the specimens failed by buckling of the studs near midspan at holes in the flanges of the studs.

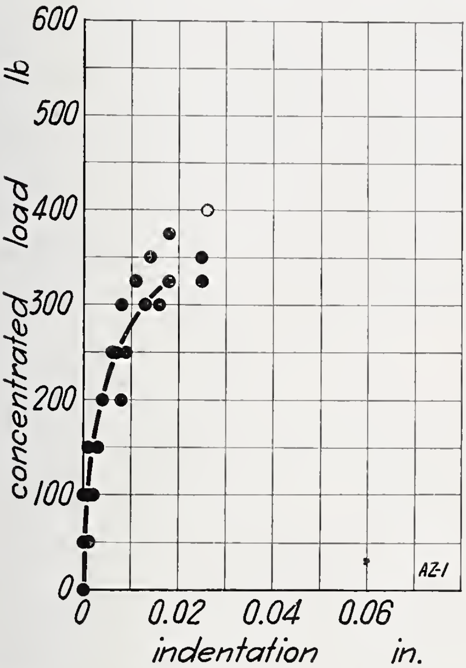

FIGURE 9.—*Concentrated load on wall AZ, load applied to inside face.*

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

4. Concentrated Load

The results are shown in table 8 and in figure 9 for wall specimens *AZ–P1*, *P2*, and *P3*, loaded on the inside face, and in figure 10 for wall specimens *AZ–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. Each of the specimens failed by punching of the disk through the inside face.

The concentrated loads were applied to the outside face of specimens *P4*, *P5*, and *P6* on the shingle siding midway between two studs. For specimens *P4* and *P5*, the shingle to which the load was applied split at a load of 900 lb, and the indentations after a load of 1,000 lb were 0.154 and 0.243 in., respectively. For specimen *P6* the disk punched through the loaded shingle at 900 lb, and the indentation after a load of 1,000 lb was 0.263 in.

5. Impact Load

The results are shown in table 8 and in figure 11 for wall specimens *AZ–I1*, *I2*, and *I3*, loaded on the inside face, and in figure 12 for wall specimens *AZ–I4*, *I5*, and *I6*, loaded on the outside face.

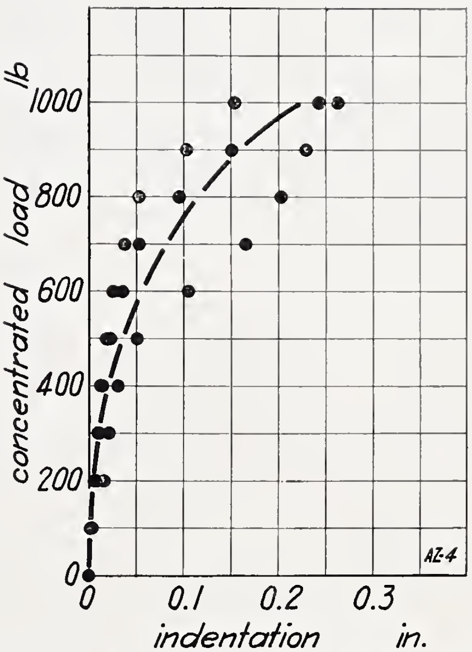

FIGURE 10.—*Concentrated load on wall AZ, load applied to outside face.*

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

The deflections shown in figure 11 were obtained from measurements to the outside face, whereas the sets were measured to the inside face. For drops greater than 7 ft, some of the sets exceeded the deflections because the inside face failed and the center stud deformed to such an extent that the set readings had to be taken on the inside of the insulation.

The impact loads were applied to the center of the inside face of specimens *I1*, *I2*, and *I3*, the sandbag striking the plaster approximately over the center stud. At drops of 2.5, 2, and 3 ft for specimens *I1*, *I2*, and *I3*, respectively, the plaster inside face of each specimen cracked transversely across the specimen at a lath joint. The deflections at these drops were 0.80, 0.69, and 0.80 in. for specimens *I1*, *I2*, and *I3*, respectively. At drops of 3.5, 3.5, and 4 ft for specimens *I1*, *I2*, and *I3*, respectively, the inside face of each specimen failed by rupture of the lath and plaster under the sandbag. For specimens *I1* and *I3* after a drop of 10 ft the sheathing was separated from the furring strips and all the studs buckled. For specimen *I2* after a drop of 10 ft the sheathing was separated from the furring strips and the center stud buckled.

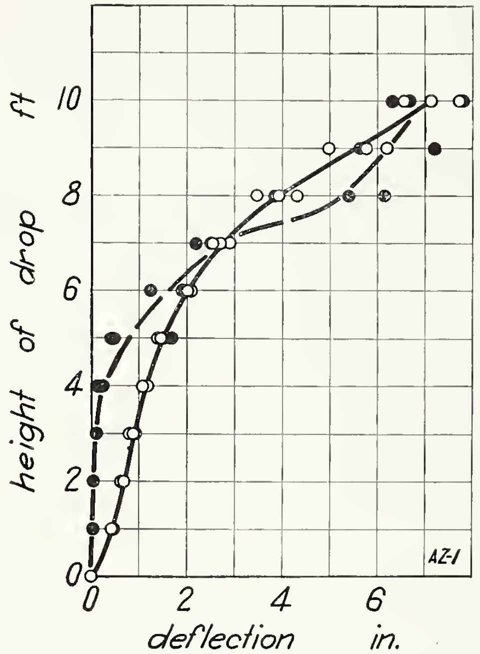

Figure 11.—*Impact load on wall AZ, load applied to inside face.*

Height of drop-deflection (open circles) and height of drop-set (solid circles) results for specimens *AZ–I1*, *I2*, and *I3* 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 shingle siding approximately over the center stud. At drops of 2, 3.5, and 3 ft for specimens *I4*, *I5*, and *I6*, respectively, the plaster inside face of each specimen cracked transversely across the specimen at a lath joint. The deflections at these drops were 0.80, 1.08, and 1.10 in. for specimens *I4*, *I5*, and *I6*, respectively. At drops of 3, 5.5 and 3.5 ft for specimens *I4*, *I5*, and *I6*, respectively, the inside face of each specimen failed by one or more pieces of lath with plaster (40 by 16 in.) falling down. For each specimen after a drop of 10 ft most of the inside face had fallen down in pieces, the sheathing separated from the furring strips, and the studs buckled.

6. Racking Load

Wall specimen *AZ–R3* under racking load is shown in figure 13. The results for wall specimens *AZ–R1*, *R2*, and *R3*, are shown in table 8 and in figure 14.

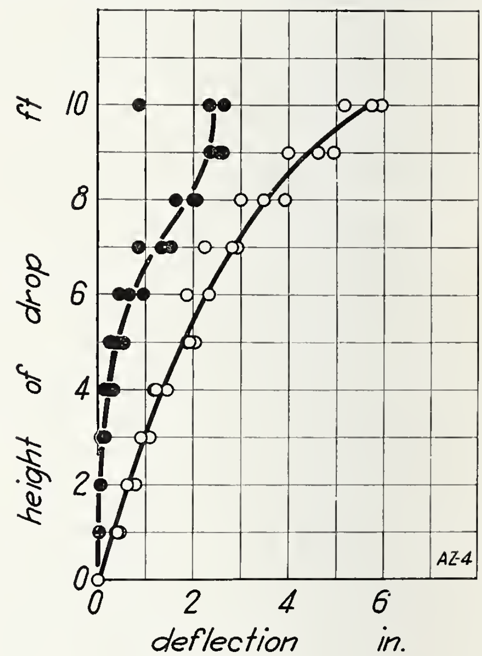

Figure 12.—*Impact load on wall AZ, load applied to outside face.*

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

The deformations and sets shown in figure 14 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 6 in. The gage length of the horizontal measuring device was 6 ft 11 in.

Each of the specimens failed by the insulation and sheathing separating from one or more studs in the panel to which the load was applied. The screws fastening the double wall to the studs and wall plate deformed under the shearing load and the heads of some of the screws finally pulled through the flanges of the studs and wall plate. In addition, the heads of some of the nails fastening the lath to the furring strips pulled through the lath. For specimen *R1* there was a slight crack in the plaster at the middle of the specimen and for specimen *R3* a crack near the upper end.

V. PARTITION *BA*

1. Sponsor's Statement

(*a*) *Materials*

Steel.—Copper-bearing sheets, hot-rolled, annealed, and pickled. The chemical composition of the steel is given in table 2 and the mechanical properties in table 3. Granite City Steel Co.

Welds.—Electric-arc welds made with mild-steel electrodes and a shielded arc. P & H "Hansen" arc welder, d-c rotary type.

Paint.—Priming, rust-resisting, red. The formula for the paint is given in table 4. Pittsburgh Plate Glass Co.

Plywood.—Three-ply, Douglas fir, 5/16 in. thick, bonded with water-resistant glue. Weyerhaeuser Sales Corporation.

Screws.—Self-tapping, 3/4 in., No. 8 (0.164-in. diam), 15 threads per in., flat head, made from SAE 1015 steel, hardened, "Parkerized." Rockford Screw Products Co.'s "Type *A*."

Wood grounds.—Western white pine, S4S (surfaced four sides).

Lath.—Gypsum, 40 by 16 by 3/8 in. United States Gypsum Co.'s "Perforated Rocklath."

Nails.—Shingle, 3d, 1¼ in. long, No. 13 gage (0.0915-in. diam), zinc coated.

Plaster.

Base coat, 2 parts sanded plaster and 1 part wood-fibered plaster, by volume. The sanded plaster was United States Gypsum Co.'s "Red Top Sanded Plaster" containing approximately 1 part neat gypsum plaster and 2 parts dry sand, by weight. The wood-fibered plaster was Grand Rapids Plaster Co.'s "Climax."

Finish coat, 1 part water to 2 parts prepared gypsum plaster, by volume. The prepared gypsum plaster was United States Gypsum Co.'s "Red Top Sand Float Finish."

Figure 13.—*Wall specimen AZ–R3 under racking load.*

(*b*) *Description*

The partition specimens were 8 ft 0 in. high, 3 ft 4 in. wide, and 5⅛ in. thick. Each specimen consisted of a welded sheet-steel frame to which the faces were fastened. The frame consisted of three sheet-steel studs, *A*, shown in figure 15, fastened to a sheet-steel soleplate, *B*, and a sheet-steel top plate, *C*, by welds, and covered with one coat of paint applied by spraying. Plywood furring strips, *D*, were fastened to the flanges of the studs and plates on both sides of the specimen by screws. Wood grounds, *E*, and gypsum lath, *F*, were fastened to the furring strips by nails, and the faces were finished with plaster, *G*.

The price of this construction in Washington, D. C., as of July 1937 was \$0.265/ft^2.

Studs.—The studs, *A*, were channels, 3 by 1¼ in., 8 ft 0 in. long, formed from sheet steel, No. 15 U. S. Std. Gage (0.0689 in. thick). The ends of the studs were crimped to fit between the flanges of the plates. The web of each stud had seven vertical slots, 1$\frac{1}{16}$ by $\frac{3}{16}$ in., for key-and-pin fastenings, two slots, 1¼ by ½ in., and nine ⅞-in. holes for conduits. There were ½-in. holes in both flanges opposite each of three pairs of slots.

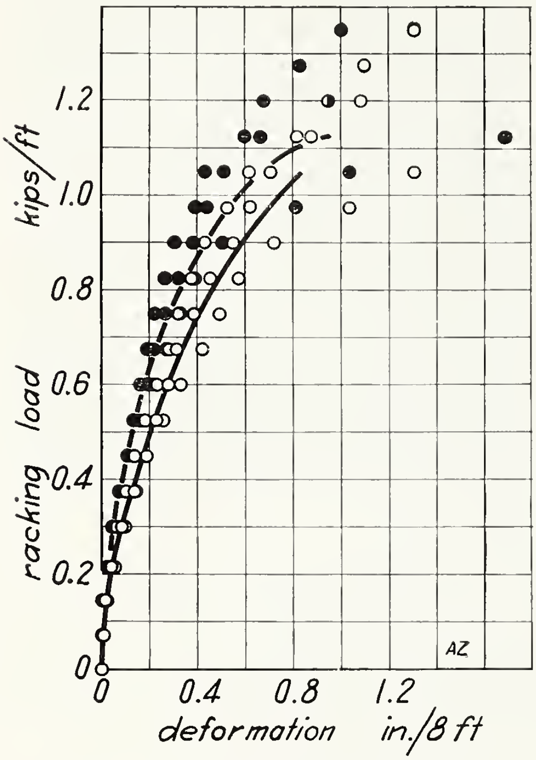

FIGURE 14.—*Racking load on wall AZ.*

Load-deformation (open circles) and load-set (solid circles) results for specimens *AZ-R1*, *R2*, and *R3*. The loads are in kips per foot of actual width of specimen.

Soleplate.—The soleplate, *B*, was a channel, 3 by ¾ in., 3 ft 3⅞ in. long, formed from sheet steel, No. 15 U. S. Std. Gage (0.0689 in. thick). The web had four slots, 1$\frac{1}{16}$ by $\frac{3}{16}$ in., and four slots, 2⅜ by ¼ in., for fastenings, and four ⅞-in. holes for conduits. Each flange had four slots, ⅝ by ½ in., and two ½-in. holes.

Top plate.—The top plate, *C*, was 3 ft 3⅞ in. long and identical in section with the soleplate, *B*. The web had 16 slots, 1$\frac{1}{16}$ by $\frac{3}{16}$ in., for key-and-pin fastenings, and two ⅞-in. holes for conduits.

Furring strips.—The furring strips, *D*, were plywood, $\frac{5}{16}$ in. thick, fastened to the flanges of the studs and plates on both sides of the specimen by screws, spaced 9 in. on centers. There was one horizontal strip and three vertical strips on each side of the frame. The horizontal strips were 7 in. wide and were fastened to the lower end of the frame to provide for fastening the baseboards in a house. The lower edges of these strips were ½ in. above the bottom of the soleplate. The vertical strips were 2 in. wide and extended from the horizontal strips to the upper end of the specimen, one along each stud, and were fastened so that one edge was on the flange, $\frac{15}{32}$ in. from the web, and the other edge extended beyond the edge of the flange.

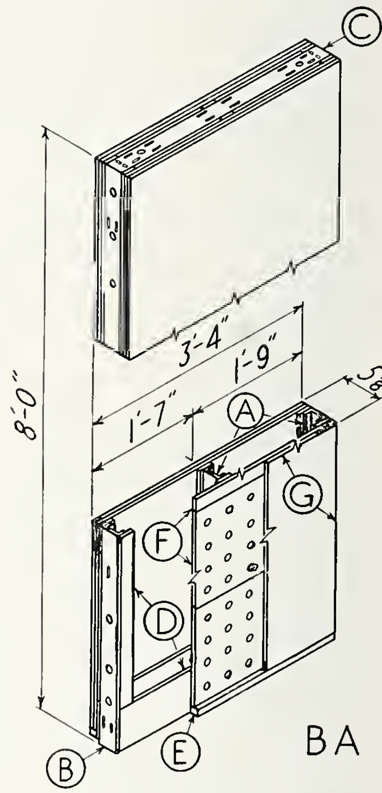

FIGURE 15.—*Partition specimen BA.*

A, stud; *B*, soleplate; *C*, top plate; *D*, furring strips; *E*, ground; *F*, lath; *G*, plaster.

Grounds.—The grounds, *E*, were wood strips ¾ by ¾ in., 3 ft 4 in. long, fastened to each horizontal furring strip by nails, spaced 11 in. on centers. The lower edges were flush with the lower edges of the furring strips.

Lath.—The lath, *F*, was 5 pieces of gypsum lath, 40 by 16 by ⅜ in., and 1 piece, 40 by 14¾ by ⅜ in., on each side of the specimen, fastened to the furring strips by nails, spaced 4 in. on centers.

Plaster.—The plaster, *G*, was ⅝ in. thick and consisted of a base coat and a finish coat.

(*c*) *Comments*

The partition panels, with the furring strips attached, are fabricated at the factory in standard widths of 3 ft 4 in., and 3 ft ⅝ in., and a height of 8 ft 8⅟₁₆ in. Lath and plaster or other inside finishes are applied after erection. The panels rest on the wood subfloor and are fastened by ¾-in. nails, with wide flat heads, driven through the slots in the soleplate. Adjacent panels are fastened by key-and-pin fastenings and the top plate is similarly fastened to the ceiling or second-floor panels.

2. Impact Load

The results for partition specimens *BA–I1*, *I2*, and *I3* are shown in table 9 and in figure 16.

Table 9.—*Structural properties of partition BA*

[Weight, 12.1 lb/ft²]

Load	Load applied	Specimen designation	Failure of loaded face, height of drop	Failure of opposite face, height of drop	Maximum height of drop	Maximum load
			ft	*ft*	*ft*	*lb*
Impact	One face; span, 7 ft 6 in.	*I1*	3.5	4.0	5.5	-----
		I2	3.0	3.5	4.5	-----
		I3	3.5	4.0	4.5	-----
	Average	-----	3.3	3.8	4.8	-----
Concentrated	One face	*P1*	-----	-----	-----	350
		P2	-----	-----	-----	375
		P3	-----	-----	-----	311
	Average	-----	-----	-----	-----	345

The impact loads were applied to the center of one face of each specimen, the sandbag striking the plaster approximately over the center stud. At drops of 2, 1.5, and 1 ft for specimens *I1*, *I2*, and *I3*, respectively, the plaster face, opposite the face to which the load was applied, cracked transversely across the specimen at a lath joint. The deflections at these drops were 0.69, 0.58, and 0.47 in., respectively. At drops of 2.5, 1.5, and 2 ft for specimens *I1*, *I2*, and *I3*, respectively, the plaster face to which the load was applied cracked transversely across the specimen. Each of the specimens failed by rupture of the loaded face, falling down of the opposite face in pieces, buckling of the center stud at midspan, and bending of the soleplate and top plate.

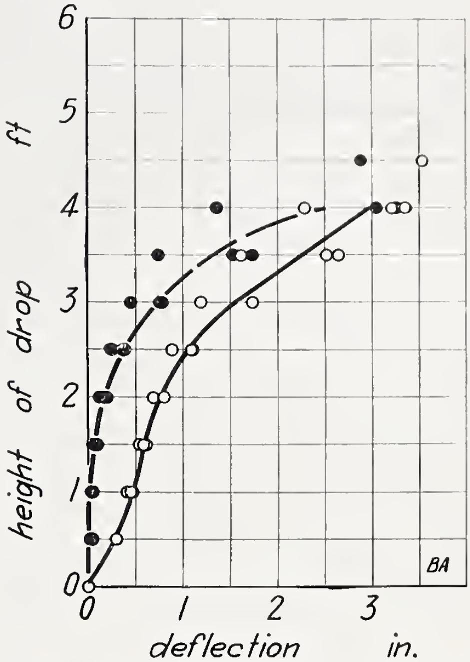

Figure 16.—*Impact load on partition BA.*

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

3. Concentrated Load

Partition specimen *BA–P2* under concentrated load is shown in figure 17. The results for partition specimens *BA–P1*, *P2*, and *P3*, are shown in table 9 and in figure 18.

The concentrated loads were applied to one face of each specimen on the plaster midway between two studs. Each of the specimens failed by punching of the disk through the loaded face.

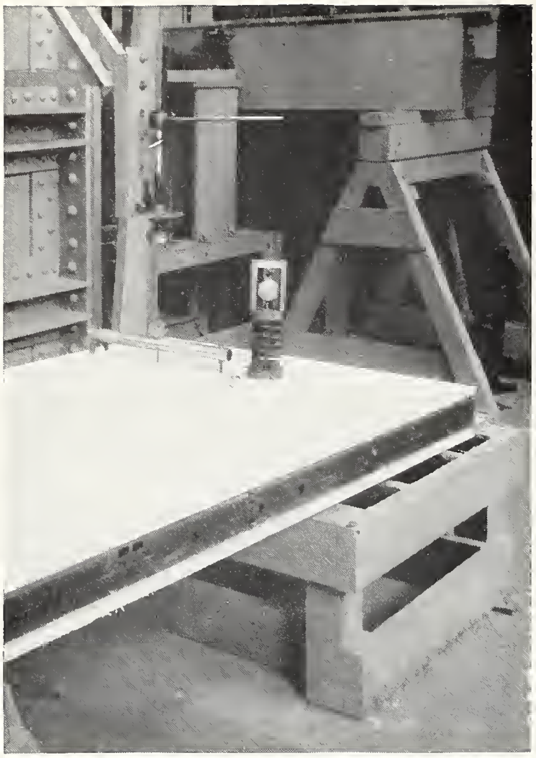

FIGURE 17.—*Partition specimen BA-P2 under concentrated load.*

VI. FLOOR *BB*

1. SPONSOR'S STATEMENT

(*a*) *Materials*

Steel.—Copper-bearing sheet, hot-rolled, annealed, and pickled. The chemical composition of the steel is given in table 2 and the mechanical properties in table 3. Granite City Steel Co.

Welds.—Electric-arc welds made with mild-steel electrodes and a shielded arc. P & H "Hansen" arc welder, d-c rotary type.

Paint.—Priming, rust-resisting, red. The formula for the paint is given in table 7. Pittsburgh Plate Glass Co.

Wood.

- Nailing strips, Douglas fir, S4S (surfaced four sides).
- Subflooring, Douglas fir, S4S (surfaced four sides).
- Flooring, red oak, No. 1.

Nails.

- Casing, 8d, 2½ in. long, No. 11½ gage (0.113-in. diam).
- Box, 7d, 2¼ in. long, No. 12½ gage (0.0985-in. diam), cement coated.

Paper.—Sheathing, felt-paper base, saturated with high-melting tar (above 180° F); weight, 30 lb/500 ft^2. The Barrett Co.'s "Slaters Felt."

(*b*) *Description*

The floor specimens were 12 ft 6 in. long, 3 ft 4 in. wide, and 9⅝ in. thick. Each specimen consisted of a welded sheet-steel frame to which the subfloor and finish floor were fastened. The frame consisted of two sheet-steel joists, *A*, shown in figure 19, spaced 3 ft 4 in. from web to web and fastened to sheet-steel end members,

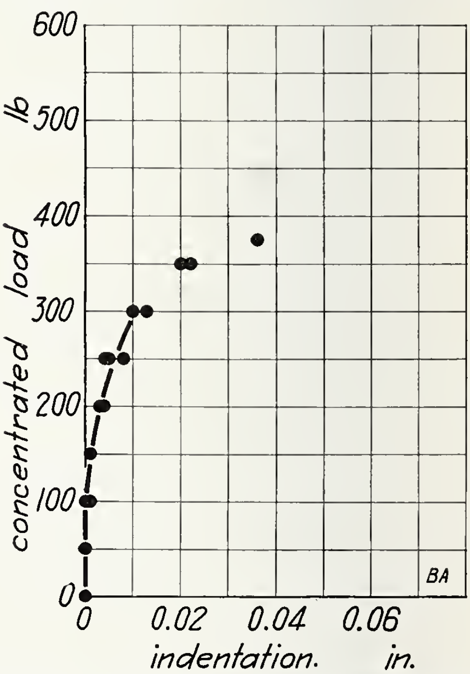

FIGURE 18.—*Concentrated load on partition BA.*

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

B, and to 10 sheet-steel cross struts, *C*, by welds, and covered with one coat of paint applied by spraying. Wood nailing strips, *D*, were clinched between the flanges of the cross struts, and a wood subfloor, *E*, was fastened to these strips by nails. The subfloor was covered with sheathing paper, *F*, over which a wood finish floor, *G*, was fastened by nails.

The price of this construction in Washington, D. C., as of July 1937 was \$0.38/ft^2.

Joists.—The joists, *A*, were channels, 8 by 1½ in., 12 ft 6 in. long, formed from sheet steel, No. 15 U. S. Std. Gage (0.0689 in. thick). The webs had 26 slots, 1¹⁄₁₆ by ³⁄₁₆ in., for key-and-pin fastenings, sixteen ½-in. holes for bolts, and seven ⅞-in. holes for conduits. The upper flange of each joist had eight slots, 1¹⁄₁₆ by ³⁄₁₆ in., and one ½-in. hole.

End members.—The end members, *B*, were 3 ft 3⅞ in. long and identical in section with the joists, *A*. The ends were crimped to fit between the flanges of the joists. The web of each end member had four slots, 1¹⁄₁₆ by ³⁄₁₆ in., for key-and-pin fastenings, four ½-in. holes for bolts, and three ⅞-in. holes for conduit. The upper flange of each end member had four slots, 1¹⁄₁₆ by ³⁄₁₆ in.

Cross struts.—The cross struts, *C*, were channels, 1⅞ by 1 in., 3 ft 3⅞ in. long, formed from sheet steel, No. 15 U. S. Std. Gage (0.0689 in. thick), stiffened by a ½-in. half-round longitudinal crimp along the center line of the web extending to within 2 in. of the ends. The struts were placed with the flanges up. There were seven triangular identations in each flange, spaced approximately 6 in. on centers.

Nailing strips.—The nailing strips, *D*, were Douglas fir, 1⅝ by 1⅝ (nominal 2 by 2 in.), 3 ft ½ in. long, set in the struts flush with the top of the joists and fastened by the triangular indentations in the flanges of the struts.

Subfloor.—The subfloor, *E*, consisted of seven boards, ²⁵⁄₃₂ by 5⅝ in. (nominal 1 by 6 in.), 12 ft 6 in. long, fastened to the nailing strips by box nails, two nails to each strip. There was approximately ⅜ in. between the edges of adjacent boards.

Sheathing paper.—The subfloor was covered with one layer of sheathing paper, *F*, fastened by the nails which fastened the flooring.

Finish floor.—The finish floor, *G*, was oak flooring, ²⁵⁄₃₂ by 2¼ in. (nominal ¹³⁄₁₆ by 2¼ in.). Each strip of flooring was fastened to the subfloor by blind nailing with four casing nails.

(*c*) *Comments*

The floor panels, with the subfloor in place, are fabricated at the factory in a standard width of 3 ft 4 in. and in lengths up to 13 ft 4 in. The finish floor is applied after erection.

The panels rest on a strip of asphalt-saturated insulating board on top of the foundation wall and are anchored to the foundation by anchor bolts and clamps which engage the lower flanges of the end members. Each floor panel is fastened to a wall panel by four ⅜-in. bolts which engage the tapped reinforcement plates welded to the studs. The inner ends of the panels are supported by an 8-in. I-beam. Adjacent panels are fastened by key-and-pin fastenings.

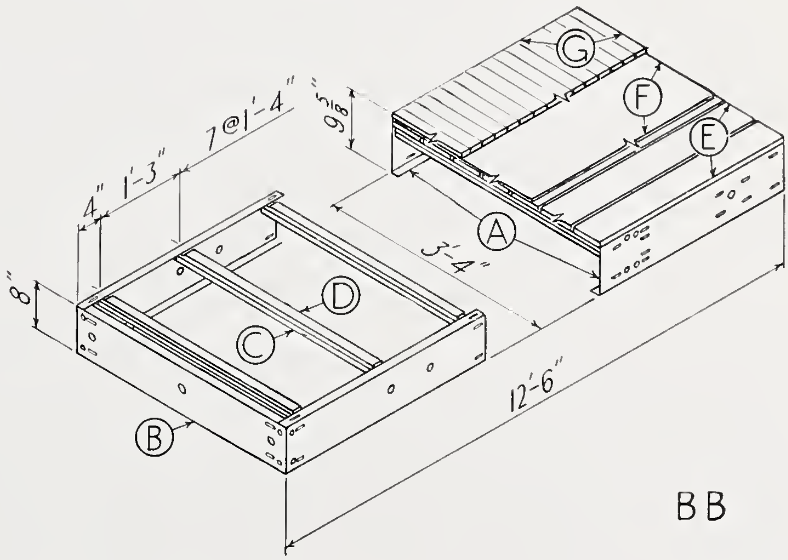

FIGURE 19.—*Floor specimen BB.*

A, joist; *B*, end member; *C*, cross strut; *D*, nailing strip; *E*, subfloor; *F*, sheathing paper; *G*, finish floor.

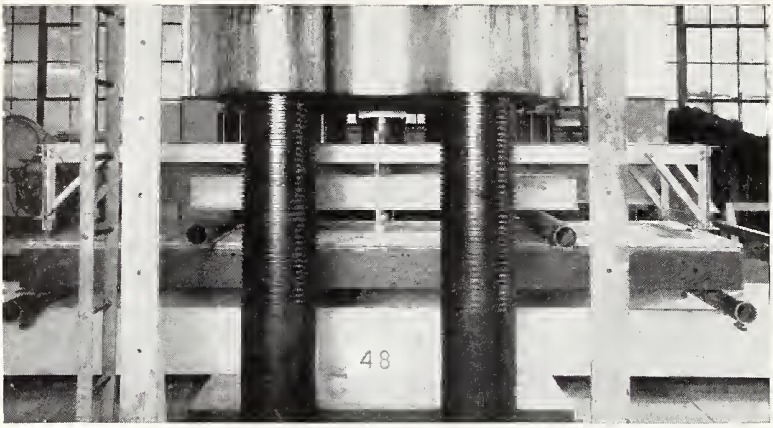

Figure 20.—*Floor specimen BB–T3 under transverse load.*

The panels designated *BB* in this report are used for the first floor of a house having a basement. Where there is no basement, insulating board is placed between the joists approximately 2 in. below the subfloor and fastened to nailing strips, ¾ by 2 in., on the underside of the subfloor.

2. Transverse Load

Floor specimen *BB–T3* under transverse load is shown in figure 20. The results for floor specimens *BB–T1*, *T2*, and *T3* are shown in table 10 and in figure 21.

Table 10.—*Structural properties of floor BB*
[Weight, 7.59 lb/ft]

Load	Load applied	Specimen designation	Maximum height of drop	Maximum load
			ft	*lb/ft²*
Transverse	Upper face; span, 12 ft 0 in.	*T1*		144
		T2		150
		T3		152
	Average			149
				lb
Concentrated	Upper face	*P1*		[a] 1,000
		P2		[a] 1,000
		P3		[a] 1,000
	Average			[a] 1,000
Impact	Upper face; span, 12 ft 0 in.	*I1*	[b] 10.0	
		I2	[b] 10.0	
		I3	[b] 10.0	
	Average		[b] 10.0	

[a] Specimen did not fail. Test discontinued.
[b] Test discontinued.

Each of the specimens failed by buckling of both joists at or between the loading rollers. No failure of the wood finish floor was observed.

3. Concentrated Load

The results for floor specimens *BB–P1*, *P2*, and *P3* are shown in table 10 and in figure 22.

The concentrated loads were applied to the finish floor of specimens *P1* and *P3* on a strip of

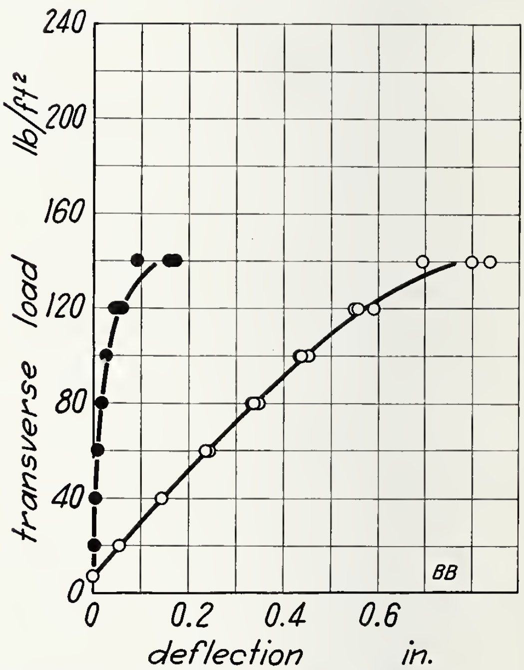

Figure 21.—*Transverse load on floor BB.*

Load-deflection (open circles) and load-set (solid circles) results for specimens *BB–T1*, *T2*, and *T3* on the span 12 ft 0 in.

the flooring near an end-matched joint which was not directly over a cross strut, and to specimen *P2* on a continuous strip of flooring which was not over a cross strut. The indentations after a load of 1,000 lb had been applied were 0.012, 0.020, and 0.022 for specimens *P1*, *P2*, and *P3*, respectively, and no other effect was observed.

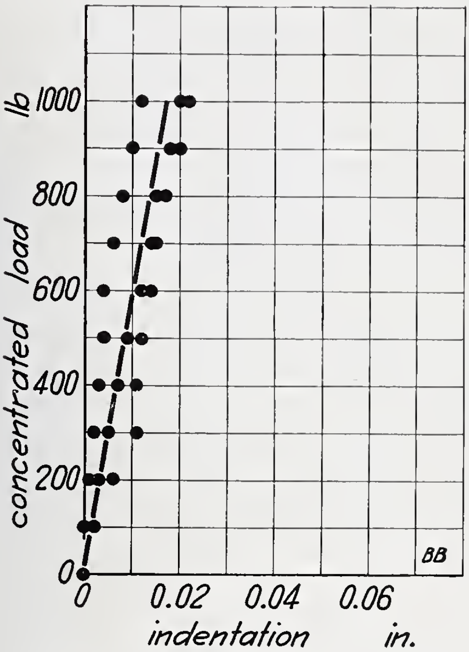

FIGURE 22.—*Concentrated load on floor BB.*

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

4. Impact Load

The results for floor specimens *BB–I1*, *I2*, and *I3* are shown in table 10 and in figure 23.

The impact loads were applied to the center of the upper face of each specimen, the sandbag striking the finish floor midway between the joists and midway between two cross struts. The sets after a drop of 10 ft were 0.72, 0.73, and 0.60 in. for specimens *I1*, *I2*, and *I3*, respectively. For specimen *I1*, one joist buckled, and for specimens *I2* and *I3* both joists buckled at midspan. No failure of the wood finish floor was observed.

VII. FLOOR *BC*

1. Sponsor's Statement

(*a*) *Materials*

All the materials used for floor *BB* and the following additional materials were used for floor *BC*:

Paper.—Kraft, duplex, moisture-resistant, consisting of two sheets of 30-lb Kraft paper (basis 24 by 36 in.; 480 sheets) cemented with asphalt; 36 in. wide; weight, 38.2 lb/1,000 ft^2. Rexford Paper Co.'s "Vapor Shields."

Lath.—Gypsum, 40 by 16 by ⅜ in. United States Gypsum Co.'s "Perforated Rocklath."

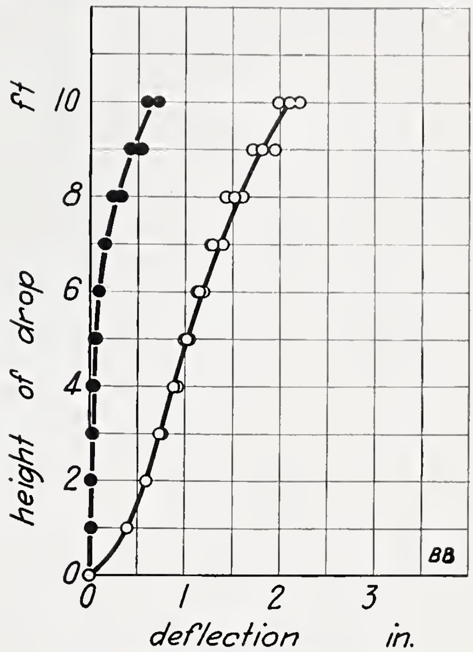

FIGURE 23.—*Impact load on floor BB.*

Height of drop-deflection (open circles) and height of drop-set (solid circles) results for specimens *BB–I1*, *I2*, and *I3* on the span 12 ft 0 in.

Nails.—Shingle, 3d, 1¼ in. long, No. 13 gage (0.0915-in. diam), zinc coated.

Plaster.

Base coat, 2 parts sanded plaster and 1 part wood-fibered plaster, by volume. The sanded plaster was United States Gypsum Co.'s "Red Top Sanded Plaster" containing approximately 1 part neat gypsum plaster and 2 parts dry sand, by weight. The wood-fibered plaster was Grand Rapids Plaster Co.'s "Climax."

Finish coat, 1 part water to 2 parts prepared gypsum plaster, by volume. The prepared gypsum plaster was United States Gypsum Co.'s "Red Top Sand Float Finish."

(*b*) *Description*

Floor specimens *BC* were the same as floor specimens *BB* with a plaster ceiling fastened to 10 additional cross struts and nailing strips. The cross struts were fastened to the joists by welds. These additional cross struts and nailing strips were the same as *C* and *D* (fig. 19), but inverted and fastened so that the nailing strips were flush with the bottom of the joists. The lower struts were directly below the upper struts.

The ceiling consisted of a layer of moisture-resistant Kraft paper, lath, and plaster. The lath was 9 pieces of gypsum lath, 40 by 16 by ⅜ in., and 2 pieces 40 by 3 by ⅜ in., fastened over the paper to the nailing strips by shingle nails, spaced 5 in. on centers. The lath was covered with plaster, ⅝ in. thick, consisting of a base coat and a finish coat.

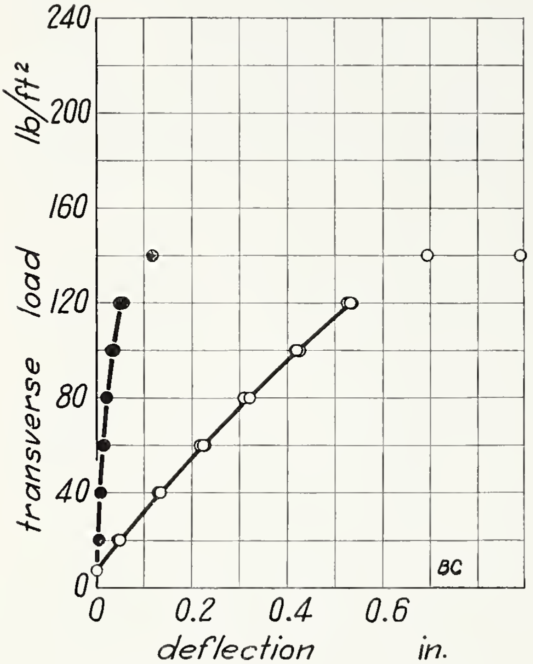

FIGURE 24.—*Transverse load on floor BC.*

Load-deflection (open circles) and load-set (solid circles) results for specimens *BC-T1*, *T2*, and *T3* on the span 12 ft 0 in.

The price of this construction in Washington, D. C., as of July 1937 was $0.46/ft².

(c) *Comments*

The panels designated *BC* in this report are used for the second floor of a house, and are supported by sheet-steel brackets, which rest on top of the first-story wall panels. The panels are fastened to the brackets by key-and-tapered-pin fastenings, and to the second-story wall panels by bolts. The finish floor and ceiling are applied in the field.

2. Transverse Load

The results for floor specimens *BC-T1*, *T2*, and *T3* are shown in table 11 and in figure 24.

TABLE 11.—*Structural properties of floor BC*
[Weight, 14.1 lb/ft²]

Load	Load applied	Specimen designation	Failure of loaded face, height of drop	Failure of opposite face, height of drop	Maximum height of drop	Maximum load
			ft	*ft*	*ft*	*lb/ft²*
Transverse	Upper face; span, 12 ft 0 in.	*T1*				146
		T2				140
		T3				149
	Average					145
						lb
Concentrated	Upper face	*P1*				[a] 1,000
		P2				[a] 1,000
		P3				[a] 1,000
	Average					[a] 1,000
Impact	Upper face; span, 12 ft 0 in.	*I1*	(b)	3.5	[c] 10.0	
		I2	(b)	9.0	[c] 10.0	
		I3	(b)	4.5	[c] 10.0	
	Average		(b)	5.7	[c] 10.0	

[a] Specimen did not fail. Test discontinued.
[b] Did not fail.
[c] Test discontinued.

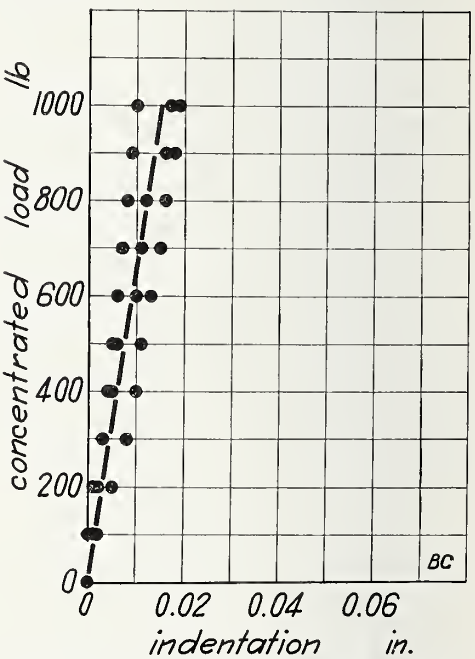

FIGURE 25.—*Concentrated load on floor BC.*

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

At loads of 80, 100, and 80 lb/ft² for specimens *T1*, *T2*, and *T3*, respectively, the plaster

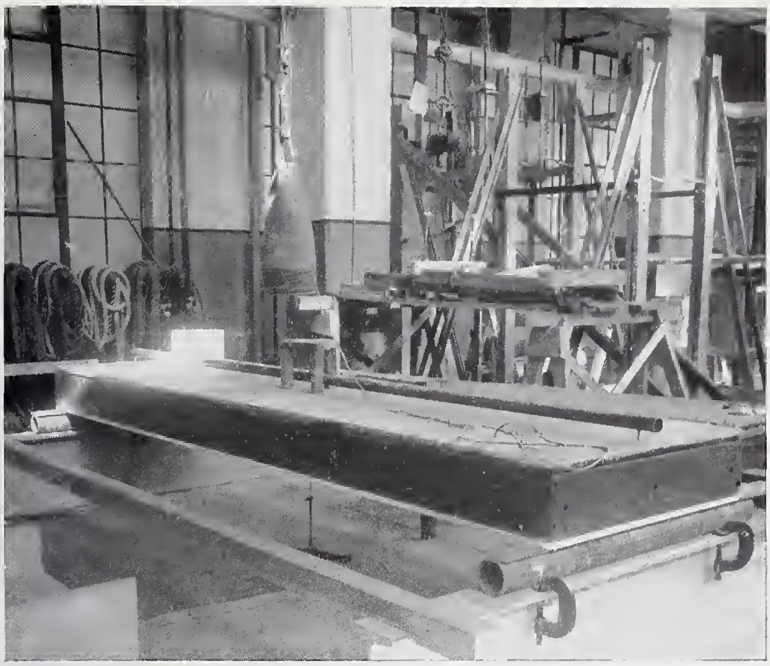

FIGURE 26.—*Floor specimen BC–I1 during impact test.*

ceiling of each specimen cracked transversely across the specimen at a lath joint. The deflections at these loads were 0.32, 0.42, and 0.32 in. for specimens *T1*, *T2*, and *T3*, respectively. The ceiling of specimen *T2* cracked at another lath joint at the maximum load. Each of the specimens failed by buckling of both joists at or between the loading rollers. The buckling occurred at holes in the upper flanges of the joists.

3. CONCENTRATED LOAD

The results for floor specimens *BC–P1*, *P2*, and *P3* are shown in table 11 and in figure 25.

The concentrated loads were applied to the finish floor of each specimen on a strip of the flooring near an end-matched joint which was not directly over a cross strut. The indentations after a load of 1,000 lb had been applied were 0.017, 0.010, and 0.019 in. for specimens *P1*, *P2*, and *P3*, respectively, and no other effect was observed.

4. IMPACT LOAD

Floor specimen *BC–I1* under impact load is shown in figure 26. The results for floor specimens *BC–I1*, *I2*, and *I3* are shown in table 11 and in figure 27.

The impact loads were applied to the center of the upper face of each specimen, the sandbag

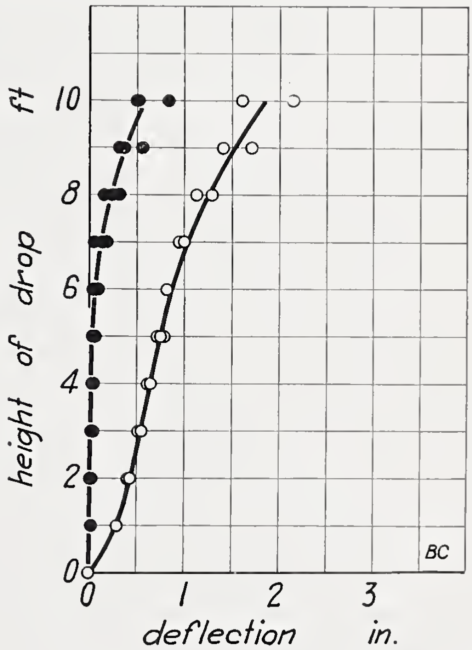

FIGURE 27.—*Impact load on floor BC.*

Height of drop-deflection (open circles) and height of drop-set (solid circles) results for specimens *BC–I1*, *I2*, and *I3* on the span 12 ft 0 in.

striking the finish floor midway between the joists and midway between two cross struts.

Specimen *I1* had an initial transverse crack across the plaster ceiling. The ceiling of specimens *I2* and *I3* cracked transversely across each specimen at a drop of 1 ft. For each of the specimens *I1*, *I2*, and *I3* at drops of 3.5, 9.0, and 4.5 ft, respectively, one piece of lath with plaster (40 by 16 in.) fell down. The sets after a drop of 10 ft were 0.83, 0.50, and 0.52 in. for specimens *I1*, *I2*, and *I3*, respectively. For specimen *I1* most of the plaster ceiling had fallen down in pieces, and both joists buckled at midspan. For specimen *I2* about one-half and for *I3* most of the plaster ceiling had fallen down in pieces, and one joist in each specimen buckled at midspan. No failure of the wood finish floor was observed.

VIII. ADDITIONAL COMMENTS BY SPONSOR

Approximately 133 houses using these constructions were completed or under construction on October 1, 1938. These houses were built entirely of prefabricated sheet-steel panels. The ceiling panels were the same as floor panels *BC*, except that insulating board, 1-in. thick, was used instead of the finish floor. The roof panels were similar to floor panels *BB*, but with 5-in. channels, and with cross struts spaced 2 ft 0 in. on centers, and without the finish floor.

The ceiling panels were fastened to sheet-steel brackets on top of the wall panels by key-and-pin fastenings. The roof panels were fastened in the same manner by brackets on the ceiling panels. The roof was covered with roofing paper and shingles. The spaces above the wall panels in cornices and gable ends were filled with loose insulation.

The sponsor supplied the information contained in the sponsor's statement. The description and drawings of the specimens were prepared by E. J. Schell and G. W. Shaw of the Bureau's Building Practice and Specifications Section, under the supervision of V. B. Phelan, from this information and from the specimens themselves. That Section also cooperated in the preparation of the report.

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, C. D. Johnson, A. J. Sussman, and L. R. Sweetman.

WASHINGTON, December 16, 1938.

The *National Bureau of Standards* was established by act of Congress, approved March 3, 1901, continuing the duties of the old Office of Standard Weights and Measures of the United States Coast and Geodetic Survey. In addition, new scientific functions were assigned to the new Bureau. Originally under the Treasury Department, the Bureau was transferred in 1903 to the Department of Commerce and Labor (now the United States Department of Commerce). It is charged with the development, construction, custody, and maintenance of reference and working standards, and their intercomparison, improvement, and application in science, engineering, industry, and commerce.

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