U. S. DEPARTMENT OF COMMERCE

BUILDING MATERIALS AND STRUCTURES

REPORT BMS37

Structural Properties of "Palisade Homes" Constructions for Walls, Partitions, and Floors Sponsored by Palisade Homes

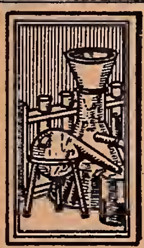
by

HERBERT L. WHITTEMORE

and AMBROSE H. STANG

with the collaboration of

THOMAS R. C. WILSON,
Forest Products Laboratory



NATIONAL BUREAU OF STANDARDS

The program of research on building materials and structures, carried on by the National Bureau of Standards, was undertaken with the assistance of the Central Housing Committee, an informal organization of Government agencies concerned with housing construction and finance, which is cooperating in the investigations through a subcommittee of principal technical assistants.

CENTRAL HOUSING COMMITTEE

SUBCOMMITTEE ON TECHNICAL RESEARCH

WALTER JUNGE, *Chairman.*
Federal Housing Administration.

A. C. SHIRE, *Vice Chairman.*
United States Housing Authority.

STERLING R. MARCH, *Secretary.*

ALBERT G. BEAR,
Veterans' Administration.

PIERRE BLOUKE,
Federal Home Loan Bank Board (Federal Loan Agency).

CARROLL W. CHAMBERLAIN,
Public Buildings Administration (Federal Works Agency).

JOSEPH M. DALLAVALLE,
Public Health Service (Federal Security Agency).

JOHN DONOVAN,
Farm Security Administration (Agriculture).

GEORGE E. KNOX,
Yards and Docks (Navy).

VINCENT B. PHELAN,
National Bureau of Standards (Commerce).

EDWARD A. POYNTON,
Office of Indian Affairs (Interior).

GEORGE W. TRAYER,
Forest Service (Agriculture).

ELSMERE J. WALTERS,
Construction Division (War).

CHAIRMEN OF SECTIONS

Specifications
CARROLL W. CHAMBERLAIN

Materials
ELSMERE J. WALTERS

Maintenance
JOHN H. SCHAEFER

Mechanical Equipment
ROBERT K. THULMAN

Methods and Practices
———————

NATIONAL BUREAU OF STANDARDS

STAFF COMMITTEE ON ADMINISTRATION AND COORDINATION

HUGH L. DRYDEN, *Chairman.*
Mechanics and Sound.

PHAON H. BATES,
Clay and Silicate Products.

HOBART C. DICKINSON,
Heat and Power.

WARREN E. EMLEY,
Organic and Fibrous Materials.

GUSTAV E. F. LUNDELL,
Chemistry.

ADDAMS S. MCALLISTER,
Codes and Specifications.

HENRY S. RAWDON,
Metallurgy.

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.]

UNITED STATES DEPARTMENT OF COMMERCE · Harry L. Hopkins, Secretary

NATIONAL BUREAU OF STANDARDS · Lyman J. Briggs, Director

BUILDING MATERIALS *and* STRUCTURES

REPORT BMS37

Structural Properties of
"Palisade Homes" Constructions for Walls, Partitions, and Floors
Sponsored by Palisade Homes

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

ISSUED FEBRUARY 13, 1940

The National Bureau of Standards is a fact-finding organization; it does not "approve" any particular material or method of construction. The technical findings in this series of reports are to be construed accordingly.

UNITED STATES GOVERNMENT PRINTING OFFICE · WASHINGTON · 1940

FOR SALE BY THE SUPERINTENDENT OF DOCUMENTS, WASHINGTON, D. C. · PRICE 10 CENTS

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 within the building industry advocating and promoting their use. The sponsor built and submitted the specimens described in this report for participation in the program outlined in report BMS2, Methods of Determining the Structural Properties of Low-Cost House Constructions. The sponsor, therefore, is responsible for the design of the constructions and for the description of the materials and of 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 walls, partitions, and floors of a house when subjected to compressive, transverse, concentrated, impact, and racking loads by standardized methods simulating the loads to which these elements 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 Forest Products Laboratory, Forest Service, United States Department of Agriculture, collaborated in the tests of those constructions which had wood structural members.

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 presented in this series 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 "Palisade Homes" Constructions for Walls, Partitions, and Floors Sponsored by Palisade Homes

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

CONTENTS

	Page
Foreword	II
I. Introduction	2
II. Sponsor and product	2
III. Specimens and tests	2
IV. Materials	3
1. Sponsor's statement	3
2. Wood	3
(a) Structural members	3
(b) Plywood wallboard	3
(c) Flooring	3
(d) Battens	3
(e) Filler strips	4
3. Fastenings	5
(a) Nails	5
(b) Box strapping	6
(c) Perforated hanger iron	6
(d) Blind fasteners	6
(e) Corrugated fasteners	6
(f) Splines	6
4. Paint	6
5. Shellac varnish	6
V. Wall *CB*	6
1. Sponsor's statement	6
(a) Description	6
(1) Four-foot wall specimens	6
(2) Eight-foot wall specimens	7
(b) Comments	8
V. Wall *CB*—Continued.	
2. Compressive load	8
3. Transverse load	9
4. Concentrated load	9
5. Impact load	10
6. Racking load	12
VI. Partition *CC*	14
1. Sponsor's statement	14
(a) Description	14
(b) Comments	15
2. Concentrated load	15
3. Impact load	16
VII. Partition *CD*	16
1. Sponsor's statement	16
(a) Description	16
(b) Comments	18
2. Concentrated load	18
3. Impact load	19
VIII. Floor *CE*	19
1. Sponsor's statement	19
(a) Description	19
(b) Comments	20
2. Transverse load	21
3. Concentrated load	21
4. Impact load	23
IX. Additional comments by sponsor	23
X. Selected references	23

ABSTRACT

For the program on the determination of the structural properties of low-cost house constructions, Palisade Homes submitted 30 specimens representing their "Palisade Homes" patented construction 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 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

To provide technical facts on the performance of constructions which might be used in low-cost houses, to discover promising new constructions, and ultimately to determine the properties necessary for acceptable performance in actual service, the National Bureau of Standards has invited the cooperation of the building industry in a program of research on building materials and structures suitable for 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 of types which have been extensively used in this country for houses were included in the program because their behavior under widely different service conditions is known to 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. The masonry specimens were built by the Masonry Construction Section of this Bureau, and the wood-frame specimens were built and tested by the Forest Products Laboratory at Madison, Wis.

The present 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 loads by 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 a ladder or other object leaning against a 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, considered as a structure, the suitability of a 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 load is removed.

II. SPONSOR AND PRODUCT

The specimens were submitted by Palisade Homes of New York, N. Y., and represented constructions patented in the United States and marketed under the trade name "Palisade Homes." These constructions consisted of wood planks with matched edges fitted together to form walls, partitions, and floors. A partition of wood-frame construction also was submitted.

III. SPECIMENS AND TESTS

The specimens, which represented three elements of a house, were assigned the following symbols: Wall, *CB;* plank partition, *CC;* frame partition, *CD;* and floor, *CE*. The specimens were assigned the designations given in table 1.

TABLE 1.—*Specimen designations*

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

[a] The concentrated and impact loads were applied to the same specimens. The concentrated load was applied first.

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 making 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 inward-projecting planks to the outside surface of the outward-projecting planks. The compressive load was applied one-third this thickness from the inside surface of the planks. The shortenings and sets were measured by means of compressometers attached to the steel loading plates through which the load was applied, not to the specimen as described in BMS2. For wood constructions under compressive load there is considerable local shortening caused by crushing of the floor plate and 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.

The deformations under racking load were measured with a right-angle deformeter consisting of a steel channel and a steel angle braced to form a rigid connection. In use the channel of the deformeter rested along the top of the specimen with the steel angle extending downward in the plane of the specimen. Two pins passed snugly through holes in the channel into the top of the specimen. A dial micrometer was attached to the lower end of the steel angle, with its spindle against the edge of the specimen at the stop. The gage length (distance from the top of the specimen to the micrometer spindle) was 6 ft 10 in. The micrometers were graduated to 0.001 in. and readings were recorded to the nearest division. This deformeter was used instead of the taut-wire mirror-scale device described in BMS2.

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 0.072 in./min. For the transverse loading of walls the speed was 0.4 in./min and of floors 0.25 in./min. These values were recommended by the Forest Products Laboratory.

The tests were begun November 9, 1938, and completed November 28, 1938. The sponsor's representative witnessed the tests.

IV. MATERIALS

1. Sponsor's Statement

The information for this statement was obtained from the sponsor and from inspection of the specimens.

The Forest Products Laboratory assisted the sponsor by identifying the species of the wood.

2. Wood

(a) *Structural Members*

Structural members were eastern spruce, merchantable grade, dressed.

One sample of the framing parts (planks, studs, floor plates, top plates, joists, and end members) was taken from each specimen. The samples were identified as spruce (*Picea sp.*)—other than Sitka spruce—with the exception that four of the samples were true fir (*Abies sp.*, probably balsam fir, *Abies balsamea*).

(b) *Plywood Wallboard*

Douglas fir, three-ply, bonded with water-resistant glue, wallboard grade (sound 1 side), sanded, ¼ in. thick.

(c) *Flooring*

Reported by the sponsor as shortleaf pine and identified as one of several species marketed as southern yellow pine, grade No. 2, 25/32 in. thick by 3³⁄₁₆ in. face width (nominal 1 by 4 in), tongued and grooved, but not end-matched.

(d) *Battens*

Ponderosa pine, grade B or better, S4S (surfaced four sides).

(e) Filler Strips

Softwood; fir, spruce, and pine, No. 2 common, S4S.

After each specimen was tested one face was removed to expose the structural members and photographs were taken to show the knots and failures. The character of the framing is indicated by figures 1 to 4.

Figure 1.—*Wall CB.*

Typical specimen, except that many of the specimens did not show "skip dressing" (dark areas).

The moisture content of the structural members, the wallboard, and the flooring is given in table 2.

Table 2.—*Moisture content of the wood*

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

Wood	Construction symbol	Moisture content [a]		
		Minimum	Maximum	Average
		Percent	*Percent*	*Percent*
Structural members, eastern spruce	*CB*	10	18	14
	CC	14	22	17
	CD	9	14	12
	CE	9	22	13
Average				14
Wallboard, Douglas-fir plywood	*CB*	8	16	10
	CC	9	10	10
	CD	11	12	11
Average				10
Flooring, shortleaf pine	*CE*	8	12	10

[a] Based on the weight when dry.

Figure 2.—*Plank partition CC.*

Typical specimen.

FIGURE 3.—*Frame partition CD.*
Typical specimen.

An electric moisture meter was used when determining the moisture content of the structural members. The instructions with the moisture meter gave correction values for several species of wood. To determine the correction factor for spruce, 30 samples from the planks, joists, and studs 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 2.4 greater than the average for the meter readings; therefore the moisture content of the spruce was obtained by adding 2.4 to the average of the meter readings and rounding the result to the nearest whole number.

The moisture content of the wallboard was determined by drying one sample from each specimen in an oven at 212° F until the weight was constant. The moisture content of the flooring was determined, using the moisture meter, and was the uncorrected reading of the meter.

3. Fastenings

(a) *Nails*

All the nails were made from steel wire except the cut flooring nails. The descriptions are given in table 3.

FIGURE 4.—*Floor CE.*
Typical specimen.

Table 3.—*Description of nails*

Type	Size	Length	Steel Wire Gage	Diameter	Finish
	Penny	*in.*	*No.*	*in.*	
Box	2	1	15½	0.0672	Bright.
Do	4	1½	14	.0800	Do.
Box, coolers	6	1⅞	13	.0915	Cement coated.
Car, heavy	4	1½	10	.1350	
Common	6	2	11½	.1130	
Do	8	2½	10¼	.1314	
Do	10	3	9	.1483	
Finishing	20	4	10	.1350	
Flooring, cut	6	2			
Lath	3	1⅛	15	.0720	Blued or bright.
Plasterboard		1½	9	.1483	
Roofing, barbed		¾	13	.0915	Bright.
Do		⅞	12	.1055	Do.
Do		1	12	.1055	Do.
Shingle	6	2	12	.1055	Do.

(*b*) *Box Strapping*

Sheet steel, either ¾ in. or ⅝ in. wide, No. 28 U. S. Std. Gage (0.0156 in. thick).

(*c*) *Perforated Hanger Iron*

Sheet steel, 1 in. wide, No. 20 U. S. Std. Gage (0.0375 in. thick) having two rows of 3/16-in. holes, ⅝ in. apart, spaced 1 1/16 in. on centers, and also a row of slots at midwidth, 3/16 by ¾ in., spaced 1 1/16 in. on centers.

(*d*) *Blind Fasteners*

Sheet steel, 1⅛ by 1 3/16 in., No. 24 U. S. Std. Gage (0.0245 in. thick), having five stamped prongs projecting ¼ in. and a slot, 3/32 in. wide, extending 7/16 in. inward from one edge. Upson Board Co.

(*e*) *Corrugated Fasteners*

Sheet steel, 1 in. wide, ⅝ in. long, No. 24 U. S. Std. Gage (0.0245 in. thick), five corrugations.

(*f*) *Splines*

Sheet steel, 1 by 4 in., No. 16 U. S. Std. Gage (0.0625 in. thick).

4. Paint

Lead and oil, slate gray. Devoe & Raynolds Co.'s No. 562.

5. Shellac Varnish

White shellac, 5 lb of shellac to 1 gal of alcohol. "Acme" brand.

V. WALL *CB*

1. Sponsor's Statement

(*a*) *Description*

Wall *CB* was a wood-plank construction having plywood wallboard on the inside face.

The price in Washington, D. C., as of July 1937, was $0.365/ft^2.

(*1*) *Four-foot wall specimens.*—The 4-ft wall specimens were 8 ft 2 in. high, 4 ft 0 in. wide, and 2¾ in. thick. Each specimen consisted of six specially edge-matched planks, *A*, as shown in figure 5, so assembled that alternate planks projected ¾ in. from the adjacent planks. The planks were fastened to a grooved floor plate, *B*, and a grooved top plate, *C*, by nails.

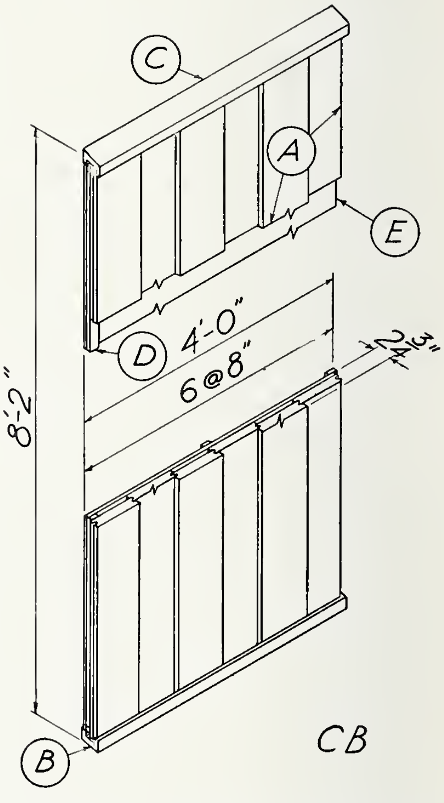


Figure 5.—*Four-foot wall specimen CB.*

A, planks; *B*, floor plate; *C*, top plate; *D*, filler strip; *E*, plywood wallboard.

The outer surface of the planks formed the outside face of the wall. The inside face of the wall was plywood wallboard, *E*, shown in figure 6, nailed to the planks and to vertical filler strips, *D*, and to horizontal filler strips, *F*.

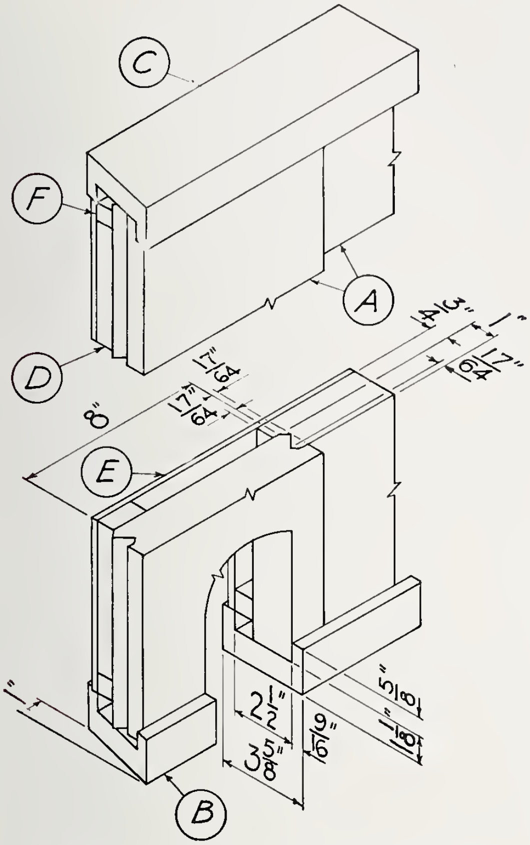


FIGURE 6.—*Details of wall specimen CB.*

A, planks; *B*, floor plate; *C*, top plate; *D*, filler strip; *E*, plywood wallboard; *F*, filler strip.

The outside face, floor plate, top plate, and edges of the specimens were covered with one coat of lead-and-oil paint. The inside face was covered with one coat of shellac varnish. Both paint and shellac were applied with a brush.

Planks.—The planks, *A*, were eastern spruce, 1¾ by 8$^{17}/_{32}$ in. (nominal 2 by 9 in), 7 ft 11¾ in. long. The planks matched as shown in figure 6, resulting in a wall surface with every alternate plank projecting ¾ in. outward from adjacent planks. After assembly the planks were held by box strapping on the inside face, as shown in figure 1. The strapping intended for each specimen consisted of two horizontal pieces, one near the bottom, the other near the top; and of four diagonal pieces, two across the lower half and two across the upper half of the specimen. However, in most specimens one or two diagonals were omitted. The strapping was fastened to each inward-projecting plank by three nails—either 4d box nails or ¾- or 1-in. roofing nails. The strapping was not taut. The planks were also fastened at each vertical joint by two to six 4d car nails toenailed from the inside.

Floor plate and top plate.—The floor plate, *B*, and the top plate, *C*, were spruce, 1¾ by 3⅝ in. (nominal 2 by 4 in.), 4 ft 1 in. long, with a 2½- by ⅝-in. groove. The ends were parallel and beveled 1 in. across the width of the plate (thickness of the wall). The plates fitted over the ends of the planks, as shown in figure 6, and were fastened to each plank by one or two 10d common nails or 20d finishing nails driven from the bottom of the floor plate and the top of the top plate. Five to eight 6d common nails or 6d shingle nails were driven through the inner lip of the floor plate and of the top plate into the planks projecting inward.

Filler strips.—The edge filler strip, *D*, was ⅝ by 1½ in., 7 ft 9¼ in. long, and was at one edge of the specimen, fastened to the projecting plank by 2d box nails spaced 1 ft. This strip is not used in a house. Horizontal filler strips, *F*, ⅝ by ⅝ in., 7$^{5}/_{16}$ in. long, were fastened near the top and bottom of each alternate plank by two 2d box nails.

Plywood wallboard.—The wallboard, *E*, was ¼-in. Douglas-fir plywood, 7 ft 10½ in. by 4 ft 0 in. It was fastened to the planks and filler strips by 3d lath nails, spaced 6 to 10 in. along the top and bottom edges of the board and about 12 in. along the vertical edges. The grain of the outer plies was vertical. Battens, ⅝ by 1½ in., 7 ft 10½ in. long, were placed vertically over the plywood wallboard at midwidth and at one edge and were fastened by 6d common nails spaced 13 in., driven through the battens and wallboard into the planks.

(*2*) *Eight-foot wall specimens.*—The 8-ft wall specimens were 8 ft 2 in. high, 8 ft 0 in. wide, and 2¾ in. thick. The specimens were similar to the 4-ft specimens except for the following details. A strip of perforated hanger iron was fastened along the top and bottom ends of the planks by ¾-in. roofing nails spaced about 3½ in. Three pieces of box strapping were fastened to the planks, one horizontally at midheight and the other two diagonally between the corners of the specimen. In addition, on specimens *R2* and *R3* there was a shorter piece of strapping placed diagonally from midheight at one edge to midwidth at the top of specimen *R2* and to midwidth at the bottom of *R3*. The floor plate and top plate were fastened to each plank by two 10d common nails. The wallboard was two pieces of plywood, 7 ft 10½ in. by 4 ft 0 in., having a vertical joint at midwidth and fastened in the same way as the wallboard of the 4-ft specimens by 3d lath nails, spaced 6 to 10 in. along the top and bottom edges and about 12 in. along the vertical edges. The grain of the outer plies was vertical.

(*b*) *Comments*

Planks are available in soft woods—fir, pine, spruce, and hemlock—and in sizes ranging from 1¼ to 3 in. in thickness, and from 3⅝ to 9½ in. in width.

In a house of this construction the walls are supported by a masonry foundation wall. A 3- by 8-in. dressed-wood sill of a dense, durable species is bolted flatwise to the foundation with the outer edge projecting about ½ in. In the upper surface of the sill there is a saw kerf, ¹⁄₁₆ in. wide by ½ in. deep. A continuous steel spline ¹⁄₁₆ by 1 in. is inserted in this slot and serves to aline the wall planks as they are placed in position. There are similar saw kerfs in both ends of the wall planks along the center line of the wall.

Either the outer joist of the floor or a ranger, 2 by 4 in., is spiked edgewise to the sill at a distance of one-half the thickness of the wall inside the saw kerf. The sill and ranger are mopped with a waterproof asphalt-bitumen compound. Five or six planks are assembled and drawn together by boat clamps, set in place, and spiked to either the floor joist or the ranger. The sill projects about 1 in. beyond the outward-projecting planks.

Before the sill is laid, the upper edge is chamfered at 45° to drip the faces of the outward-projecting planks. After the planks are in place, the sill between the outer planks is beveled at 30° to drip the faces of the recessed planks.

The top plate may be softwood, 2 by 4 in., but preferably hardwood, 1½ by 5 in., for better alinement and more secure nailing. The plate is connected to the wall planks by a steel spline which fits into saw kerfs in the top of the planks and in the lower surface of the plate, and is fastened by nails passing through the plate into the planks.

Door and window frames are planks matched to fit the wall planks. Diagonal bracing in the walls may be provided by special shear fasteners in the vertical joints between planks, by heavy box strapping fastened diagonally to the inside surface of the planks, or by diagonal furring for lath and plaster or other finishing.

Instead of assembling the planks on the building site, prefabricated units may be assembled in a shop, each consisting of eight or more prime-coated planks. Some of the advantages of prefabricated units are more rapid erection and lower cost.

The wall planks may serve as outside face as well as structural members, and two or three coats of paint complete the outside finish; although, if desired, conventional finishes, such as drop siding, lap siding, or shingles, may be readily applied. Lath and plaster or wallboard may be applied for inside finish. The spaces formed by alternate planks serve as chases for conduit and piping and, if closed by the interior and exterior finishes, decrease the heat transmission through the wall.

For a two-story house, about one-fourth of the planks are full height. Shorter planks are placed above or below openings and may be spliced if they extend the full height.

2. Compressive Load

Wall specimen *CB–C1* under compressive load is shown in figure 7. The results for wall specimens *CB–C1*, *C2*, and *C3* are shown in table 4 and in figures 8 and 9.

The lateral deflections shown in figure 9 were plotted to the right of the vertical axis for deflections of the specimen 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, specimens *C1* and *C2* deflected initially toward the inside face, whereas specimen *C3* deflected toward the outside face. As the load was increased, the deflection of specimen *C1* did not change appreciably and at the maximum load it was zero. The deflection of specimen *C2* decreased to zero and then increased slightly toward the outside face up to the maximum load. Specimen *C3* deflected toward the outside face throughout the test. The lateral deflection toward the inside face was probably due to the stiffness of the inside face offsetting the effect of the eccentric loading. The change in direction of the deflections of specimens *C1* and *C2* indicated buckling of the inside face.

Each of the specimens failed by crushing of the inside edge of the top plate locally at the ends of the planks, causing the top plate to rotate and allowing the specimens to push out under load without breaking the planks. In addition, on specimen *C1* the plywood wallboard separated from the planks near the top plate by pulling the nails from the planks; in specimen *C2* the top plate split; and in specimen *C3* the top plate pulled the nails from the planks.

Table 4.—*Structural properties, wall CB*

[Weight, 5.24 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*	[a] *Kips/ft*
Compressive	Upper end, one-third the thickness (0.83 in.) from the inside surface of the planks (see section III).	*C1*				10.00
		C2				10.00
		C3				9.09
	Average					9.70
						lb/ft²
Transverse	Inside face; span, 7 ft 6 in.	*T1*				500
		T2				546
		T3				479
	Average					508
Do	Outside face; span, 7 ft 6 in.	*T4*				546
		T5				582
		T6				538
	Average					555
						lb
Concentrated	Inside face	*P1*				700
		P2				650
		P3				510
	Average					620
Do	Outside face	*P4*				[b] 1,000
		P5				[b] 1,000
		P6				[b] 1,000
	Average					[b] 1,000
Impact	Inside face; span, 7 ft 6 in.	*I1*	(c)	(c)	[b] 10.0	
		I2	(c)	(c)	[b] 10.0	
		I3	(c)	(c)	[b] 10.0	
	Average		(c)	(c)	[b] 10.0	
Do	Outside face; span, 7 ft 6 in.	*I4*	7.0	(c)	[b] 10.0	
		I5	(c)	(c)	[b] 10.0	
		I6	7.0	(c)	[b] 10.0	
	Average			(c)	[b] 10.0	
						[a] *Kips/ft*
Racking	Near upper end	*R1*				0.454
		R2				.404
		R3				.360
	Average					.406

[a] A kip is 1,000 lb.
[b] Test discontinued. Specimen did not fail.
[c] Face did not fail.

3. Transverse Load

The results under transverse load are shown in table 4 and in figure 10 for wall specimens *CB–T1*, *T2*, and *T3*, loaded on the inside face, and in figure 11 for wall specimens *CB–T4*, *T5*, and *T6*, loaded on the outside face.

In specimen *T1* at a load of 400 lb/ft² two planks ruptured at or between the loading rollers, and at the maximum load the specimen failed by rupture of two more planks between the loading rollers. Specimen *T2* failed at maximum load by rupture of all the planks at a loading roller. In specimen *T3* at a load of 450 lb/ft² one plank ruptured between the loading rollers and at the maximum load the specimen failed by rupture near midspan of three more planks. The plywood wallboard of the specimens was undamaged, but on specimen *T1* it had separated from the planks.

At the maximum loads specimens *T4*, *T5*, and *T6* failed by rupture of all or all but one of the planks at or between the loading rollers. The plywood wallboard was undamaged but separated from the planks at the ruptures and at the ends of the specimens by pulling the nails from the planks.

4. Concentrated Load

The results of the concentrated-load tests are shown in table 4 and in figure 12 for wall specimens *CB–P1*, *P2*, and *P3*, loaded on the inside face, and in figure 13 for wall specimens *CB–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 plywood wallboard over the cavity between the wallboard and a projecting plank, about 2

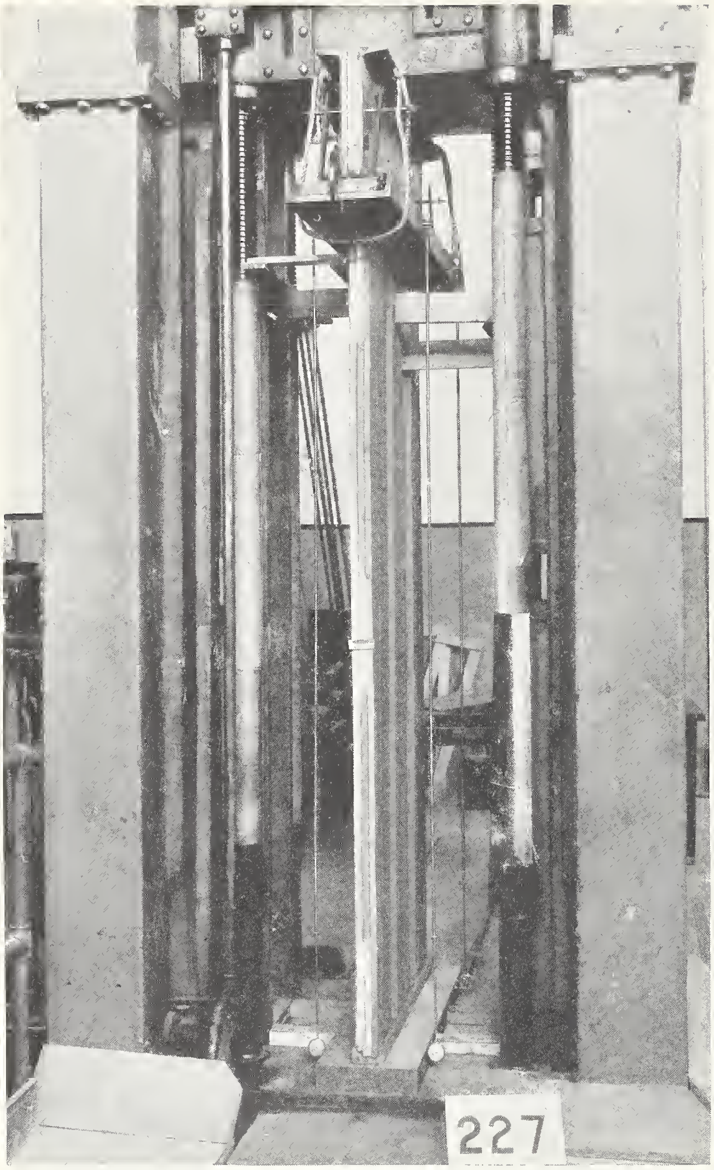


FIGURE 7.—*Wall specimen CB–C1 under compressive load.*

CB–I1, I2, and *I3,* loaded on the inside face, and in figure 15 for wall specimens *CB–I4, I5,* and *I6,* loaded on the outside face.

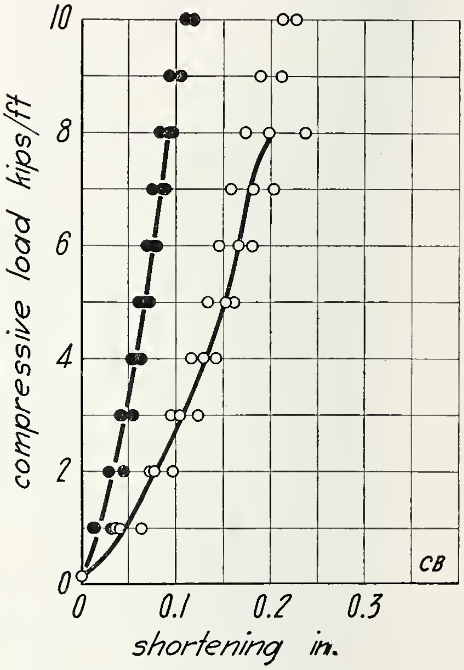


FIGURE 8.—*Compressive load on wall CB.*

Load-shortening (open circles) and load-set (solid circles) results for specimens *CB–C1, C2,* and *C3.* The load was applied one-third the thickness (0.83 in.) from the inside surface of the planks. The loads are in kips per foot of actual width of specimen.

ft from one end. Each of the specimens failed by punching of the disk through the wallboard.

The concentrated loads were applied to the outside face of specimens *P4, P5,* and *P6* on a plank, about 2½ ft from the top end. The indentations after a load of 1,000 lb had been applied were 0.047, 0.111, and 0.055 in. in specimens *P4, P5,* and *P6,* respectively, and no other effect was observed.

5. Impact Load

The results of the impact test are shown in table 4 and in figure 14 for wall specimens *CB–I1, I2,* and *I3,* loaded on the inside face, and in figure 15 for wall specimens *CB–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 center batten and the wallboard. At drops of 3, 5, and 10 ft for specimens *I1, I2,* and *I3,* respectively, there was noticeable opening of the joint between the center planks where the sandbag struck. In addition, in specimen *I2* at a drop of 7.5 ft the floor plate split at the edge of the specimen and the filler strip along the edge separated from the plank. The sets after a drop of 10 ft were 0.177, 0.096, and 0.114 in. for specimens *I1, I2,* and *I3,* respectively, and no other effect was observed.

The impact loads were applied to the center of the outside face of specimens *I4, I5,* and *I6,* the sandbag striking the planks. In specimen *I4* at a drop of 4.5 ft there was noticeable opening of the joint between the two center planks

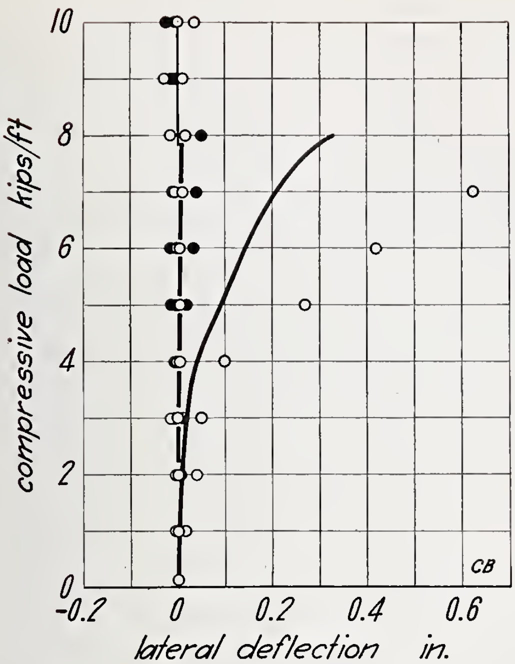


Figure 9.—*Compressive load on wall CB.*

Load-lateral deflection (open circles) and load-lateral set (solid circles) results for specimens *CB–C1*, *C2*, and *C3*. The load was applied one-third the thickness (0.83 in.) from the inside surface of the planks. The loads are in kips per foot of actual width of specimen. The deflections and sets are for a gage length of 7 ft 10 in., the gage length of the deflectometers.

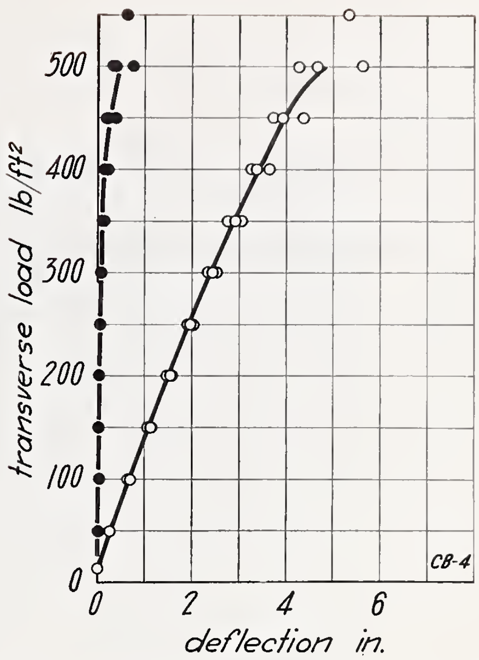


Figure 11.—*Transverse load on wall CB, load applied to outside face.*

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

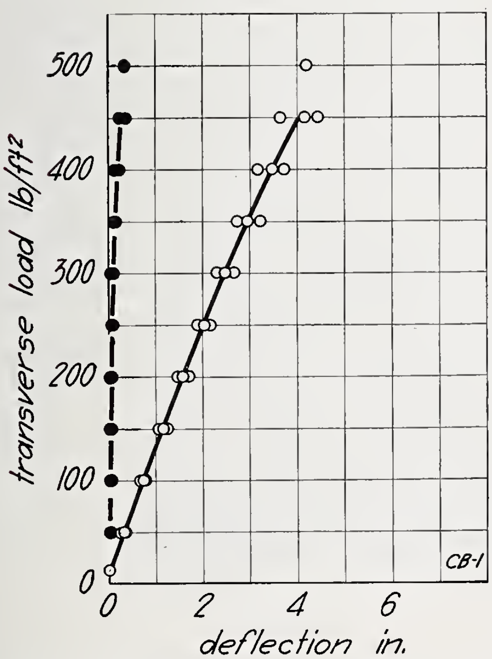


Figure 10.—*Transverse load on wall CB, load applied to inside face.*

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

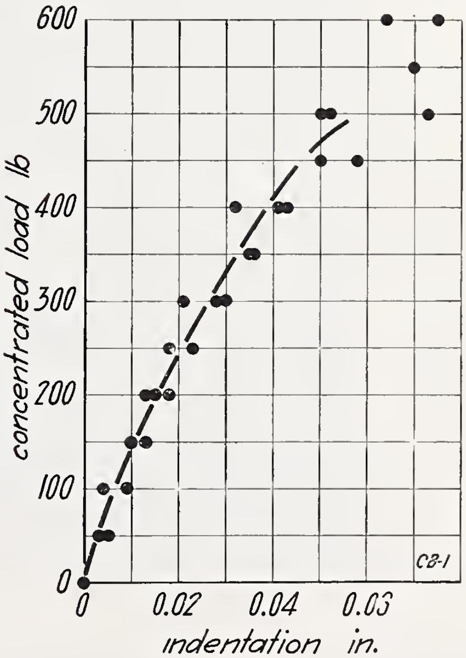


Figure 12.—*Concentrated load on wall CB, load applied to inside face.*

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

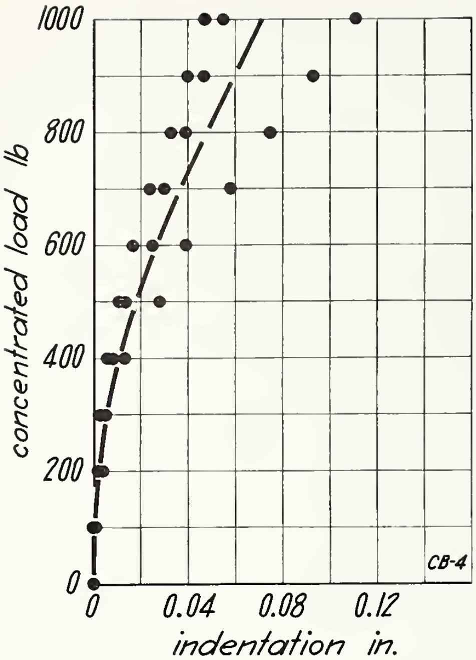


FIGURE 13.—*Concentrated load on wall CB, load applied to outside face.*

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

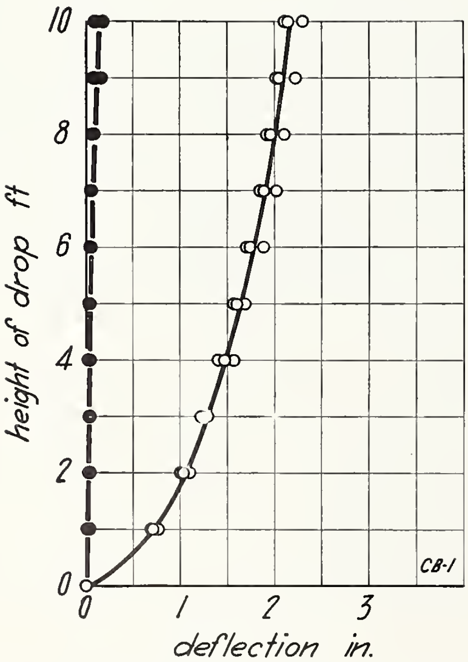


FIGURE 14.—*Impact load on wall CB, load applied to inside face.*

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

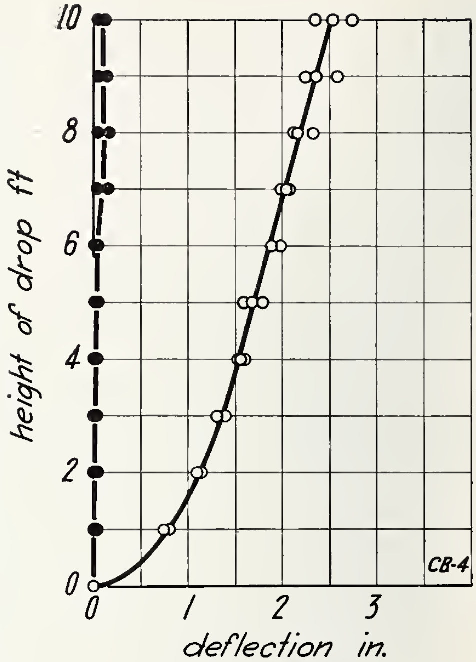


FIGURE 15.—*Impact load on wall CB, lood opplied to outside face.*

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

near midspan, and at a drop of 7 ft the planks separated at the matched joint, causing failure of the outside face. At a drop of 9 ft the battens started to separate from the plywood wallboard by pulling the nails from the planks at one edge of the specimen. At the 10-ft drop the floor plate and top plate separated from the planks, and the floor plate split. The set after a drop of 10 ft was 0.132 in. In specimen *I5* at a drop of 5.5 ft the top plate split, and at the 6.5-ft drop there was noticeable displacement between the two center planks at midspan. The set after a drop of 10 ft was 0.042 in. In specimen *I6* at a drop of 7 ft the joint between the two center planks opened at midspan, causing failure of the outside face. At a drop of 8.5 ft the edge filler strip separated from the plank, and at a drop of 9.5 ft the edge batten also separated. The set after a drop of 10 ft was 0.124 in.

6. Racking Load

Wall specimen *CB–R2* under racking load is shown in figure 16. The results for wall specimens *CB–R1*, *R2*, and *R3* are shown in table 4 and in figure 17.

The load was applied to the edge of the plank at one upper corner of the specimen and the stop was in contact with the edge of the plank at the diagonally opposite corner. In specimen *R1* at a load of 0.312 kip/ft the plywood wallboard separated from the loaded edge of the specimen, pulling the nails from the plank and the filler strip. There was noticeable vertical displacement of the plywood wallboard panels at the joint in the wallboard Under a load of 0.350 kip/ft there was noticeable vertical displacement at all the joints between the planks, and at the maximum load the specimens failed by continued slipping of the planks at the joints. Both plywood wallboard panels had pulled the nails from the

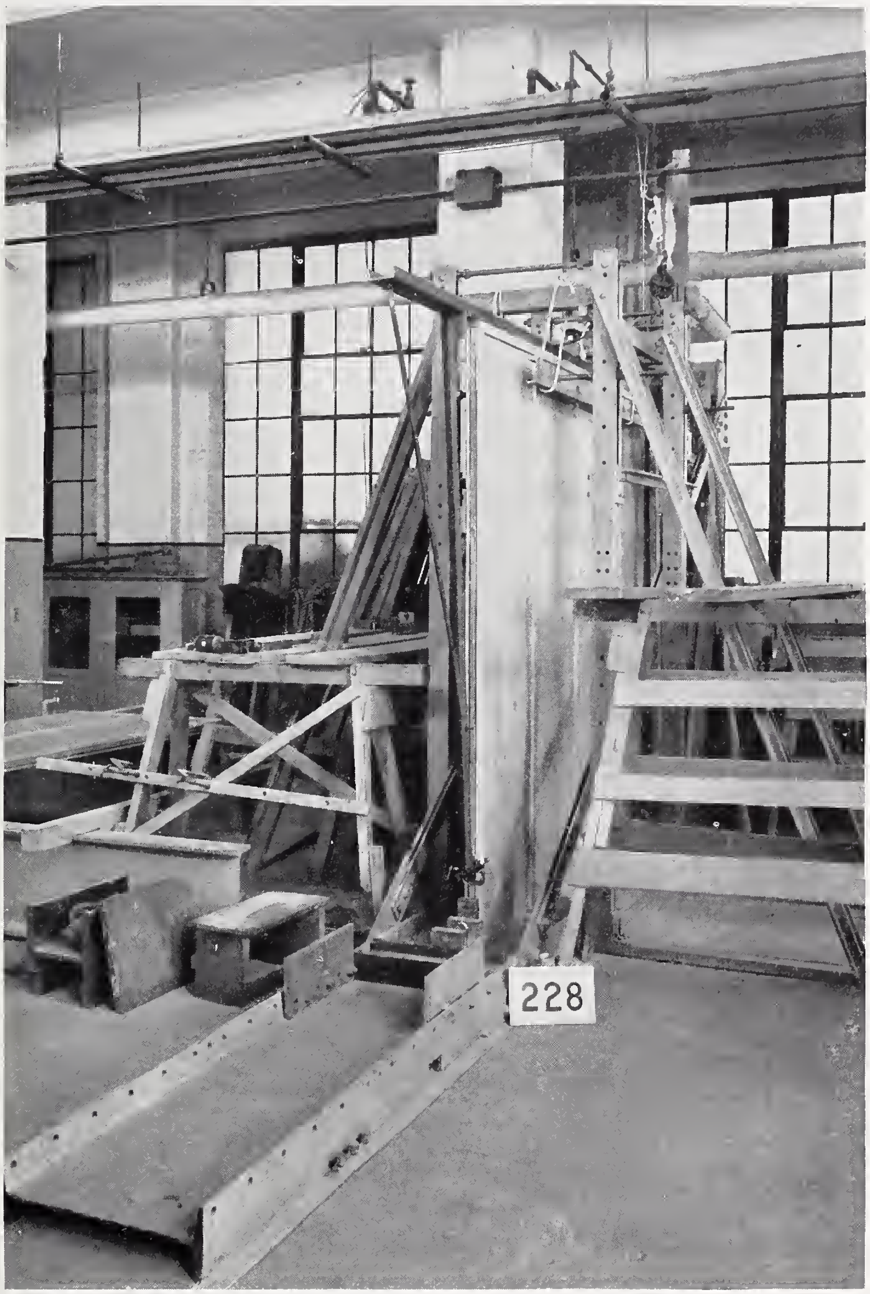


Figure 16.—*Wall specimen CB–R2 under racking load.*

planks, and the top plate had bowed upward at midwidth.

In specimens *R2* and *R3* at loads of 0.240 and 0.200 kip/ft, respectively, there was noticeable vertical displacement at the joint in the wallboard; and at loads of 0.320 and 0.360 kip/ft respectively, the wallboard separated from the loaded edge of the specimens. At the maximum loads each of the specimens failed by continued slipping of the planks at the joints. The wallboard had pulled the nails from the planks, and the top plate had bowed upward at midwidth. Also the floor plate of specimen *R3* had separated from the planks, leaving the nails in the planks.

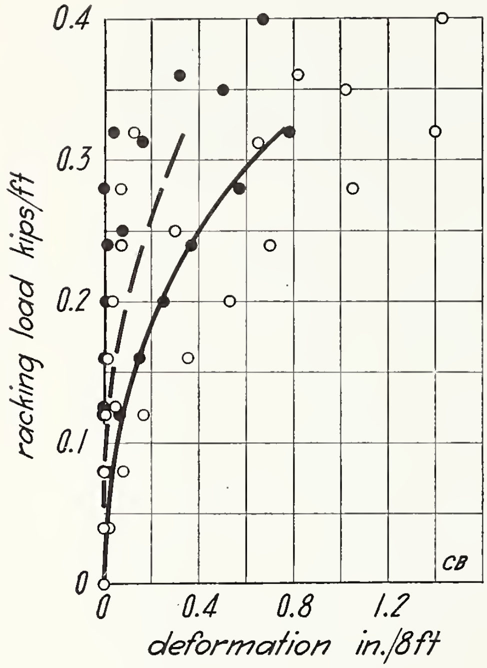


FIGURE 17.—*Racking load on wall CB.*

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

VI. PARTITION *CC*

1. SPONSOR'S STATEMENT

(a) *Description*

Partition *CC* was a wood-plank construction having plywood wallboard on both faces. It was similar to wall *CB* except that the planks were 1⅛ by 5⅜ in., not 1¾ by 8¹⁷⁄₃₂ in.; they projected ¼ in., not ¾ in.; and the edges were tongued and grooved, not edge-matched. Also, both faces were plywood wallboard, not one face.

The price in Washington, D. C., as of July 1937, was $0.40/ft².

The plank partition specimens shown in figure 18, were 8 ft 2 in. high, 4 ft ⅜ in. wide, and 1⅞ in. thick. Each specimen consisted of nine tongue-and-grooved planks, *A*, so assembled that alternate planks projected ¼ in. The planks were fastened to a floor plate, *B*, and a top plate, *C*, by splines. The faces consisted of plywood wallboard, *D*. The floor plate, top plate, and edges of the specimens were covered with one coat of lead-and-oil paint. The faces were covered with one coat of shellac varnish. Both paint and shellac were applied with a brush.

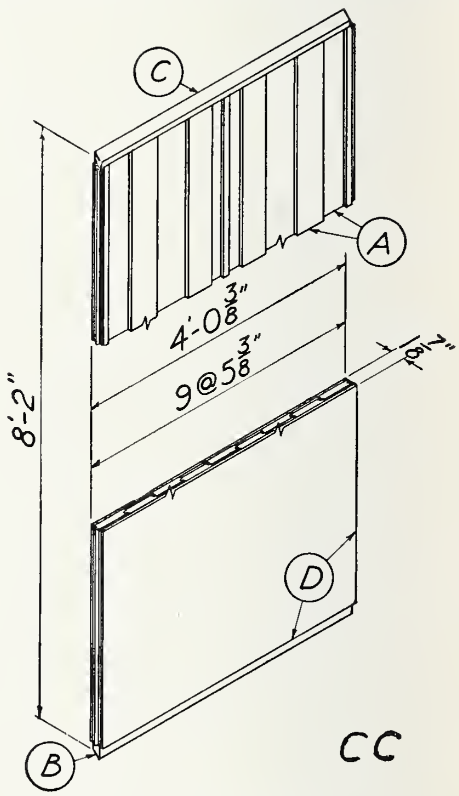


FIGURE 18.—*Partition specimen CC.*

A, planks; *B*, floor plate; *C*, top plate; *D*, plywood wallboard.

Planks.—The planks, *A*, were spruce, 1⅛ by 5⅜ in., 7 ft 10¹⁵⁄₁₆ in. long. The edges of each plank were tongued and grooved on a line ⅛ in. from midthickness, and the planks were assembled as shown in figure 19. After assembly the planks were held by box strapping fastened to both faces. The strapping consisted of two horizontal strips, one near the bottom, the other near the top, and one strip applied diagonally

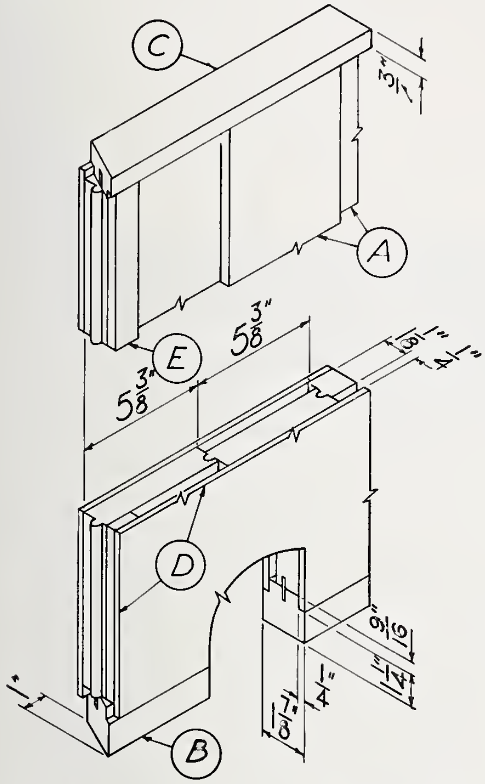


FIGURE 19.—*Details of partition specimen CC.*

A, planks; *B*, floor plate; *C*, top plate; *D*, plywood wallboard; *E*, filler strip.

from a lower to an upper corner, as shown in figure 2. The strapping was fastened to each projecting plank by two nails—either 3d lath nails or ⅞-in. or 1-in. roofing nails. After assembling the planks, the upper and lower ends of the assembled unit were grooved ⅛ by ½ in. at midthickness.

Floor plate.—The floor plate, *B*, was spruce, 1⅞ by 1¹³⁄₁₆ in., 4 ft 1⅜ in. long, having ⁹⁄₁₆- by ¼-in. recesses at two edges. The ends were parallel and beveled 1 in. The plate was connected to the planks by five steel splines spaced along a 1¹⁄₁₆- by ½-in. groove in the plate and fitted into the groove in the planks.

Top plate.—The top plate, *C*, was spruce, 1⅞ by 1¼ in., 4 ft 1⅜ in. long, having ½- by ¼-in. recesses at two edges. The ends were parallel and beveled 1 in. The plate was connected to the planks by five splines spaced along a ¹⁄₁₆- by ½-in. groove in the plate and fitted into the groove in the planks.

Plywood wallboard.—The wallboard, *D*, was ¼-in. Douglas-fir plywood, 8 ft 0 in. by 4 ft 0 in. The edges of the wallboard fitted into the recesses in the floor plate and top plate, and were fastened by 3d lath nails spaced 5 in., driven through the wall board into the plates. The wallboard was fastened to the planks by blind fasteners, spaced 16 in. along both vertical edges and along the vertical center line of the specimen. On one side of the specimen each fastener was attached by a 3d lath nail directly to the planks, on the other side to the filler strips. The grain of the outer plies was vertical.

Filler strips.—The filler strips, *E*, were ¼ by 1½ in., 7 ft 10¹⁵⁄₁₆ in. long. There were three strips on one side of the specimen, fastened to the recessed planks at the edges and at midwidth by 3d lath nails.

(*b*) *Comments*

Partition planks are available in soft woods, such as fir, pine, spruce, and hemlock; and in sizes ranging from 1¹⁄₁₆ to 1⅝ in. thickness and from 3¼ to 9½ in. in width. In a house the ends of the planks rest on a wood floor plate fastened to the subfloor and fitted with a steel spline which holds the planks in place. A wood top plate similar to the floor plate and nailed either to the ceiling joists or to the second-story floor joists fastens the planks at the top.

The partition may be used without additional finishes other than paint or varnish. However, other finishes, such as lath and plaster or any kind of wallboard, may readily be applied to the planks.

2. CONCENTRATED LOAD

Partition specimen *CC–P1* under concentrated load is shown in figure 20. The results for partition specimens *CC–P1*, *P2* and *P3* are shown in table 5 and in figure 21.

The concentrated loads were applied to one face of specimens *P1*, *P2*, and *P3* on the wallboard over the cavity between the wallboard

Table 5.—*Structural properties, partition CC*

[Weight, 4.20 lb/ft²]

Load	Load applied	Specimen designation	Maximum height of drop	Maximum load
			ft	*lb*
Concentrated	One face	*P1*		[a] 1,000
		P2		[a] 1,000
		P3		[a] 1,000
	Average			[a] 1,000
Impact	One face; span, 7 ft 6 in.	*I1*	[a] 10.0	
		I2	[a] 10.0	
		I3	[a] 10.0	
	Average		[a] 10.0	

[a] Test discontinued. Specimen did not fail.

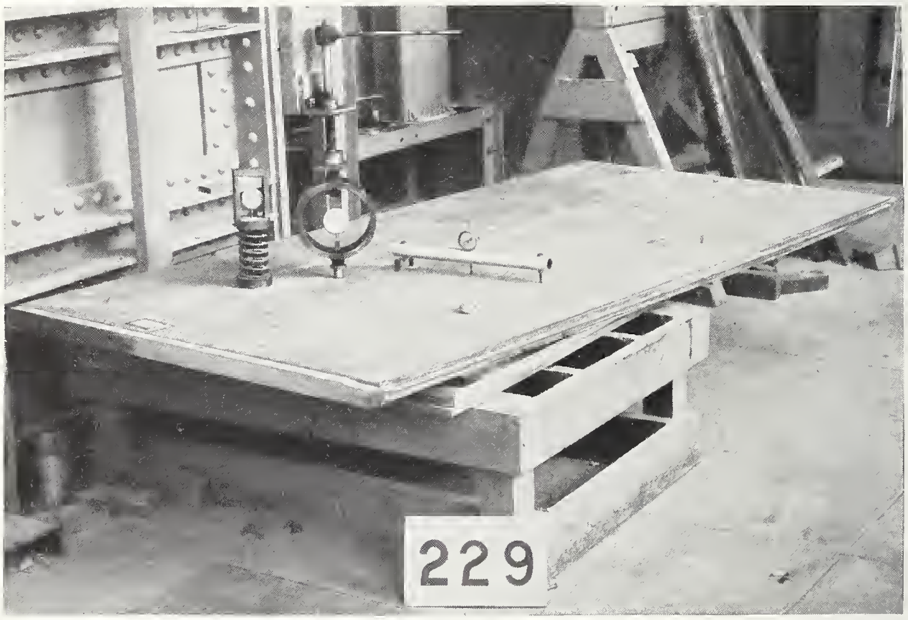


Figure 20.—*Partition specimen CC–P1 under concentrated load.*

and a plank, about 2 ft from one end. The indentations after a load of 1,000 lb had been applied were 0.062, 0.080, and 0.082 in. for specimens *P1*, *P2*, and *P3*, respectively, and no other effect was observed.

3. Impact Load

The results of the impact tests for partition specimens *CC–I1*, *I2*, and *I3* are shown in table 5 and in figure 22.

The impact loads were applied to one face of the specimens, the sandbag striking the plywood wallboard. At drops of 4, 5, and 4 ft for specimens *I1*, *I2*, and *I3*, respectively, the wallboard started to separate from the planks. The sets after a drop of 10 ft were 0.180, 0.145, and 0.000 in. for specimens *I1*, *I2*, and *I3*, respectively, and both plywood-wallboard faces were separated from the planks. The zero set of specimen *I3* was due to th springing upward of the loose wallboard.

VII. PARTITION *CD*

1. Sponsor's Statement

(*a*) *Description*

Partition *CD* was a wood-frame construction having plywood wallboard on both faces and was similar to partition *CC* except that the structural members were studs and not planks.

The price in Washington, D. C., as of July 1937, was $0.285/ft².

The frame partition specimens, shown in figure 23, were 8 ft 2 in. high, 4 ft 0 in. wide, and 2 in. thick. Each specimen consisted of a wood frame to which the faces were fastened. The frame consisted of three full-sized studs, *A*, and two half-sized studs, *B*, fastened to a floor plate, *C*, and a top plate, *D*. The faces consisted of plywood wallboard, *E*. The floor plate, top plate, and edges of the specimen were covered with one coat of lead-and-oil paint. The faces were covered with one coat of shellac varnish. Both paint and shellac were applied with a brush.

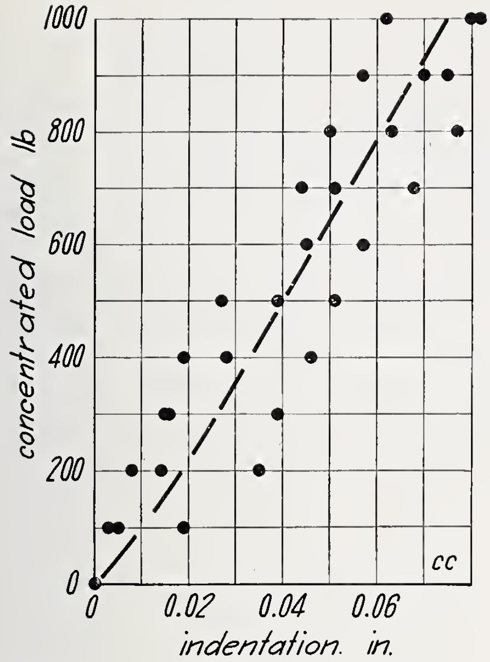


FIGURE 21.—*Concentrated load on partition CC.*

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

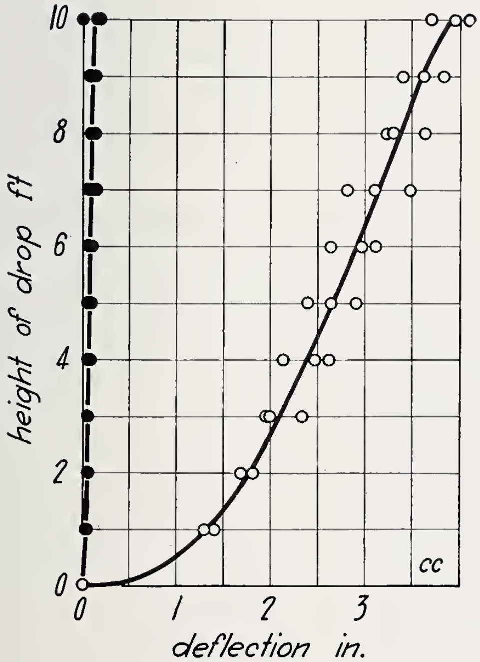


FIGURE 22.—*Impact load on partition CC.*

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

Studs.—The full-sized studs, *A*, were spruce, 1⅜ by 1¾ in., 7 ft 11⅜ in. long, with ⅜- by ¼-in. recesses in two edges, as shown in figure 24. They were spaced 1 ft 0 in. on centers.

The half-sized studs, *B*, were spruce, 25/32 by 1¾ in., 7 ft 11⅜ in. long, with a ⅜- by ¼-in. recess in one edge and were at the edges of the specimen.

Floor plate.—The floor plate, *C*, was spruce, 1⅝ by 2 11/16 in., 4 ft. 1 in. long, with two

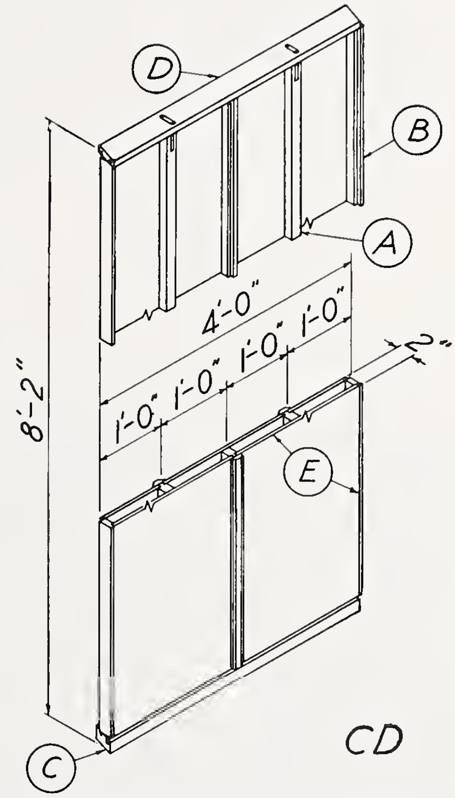


FIGURE 23.—*Partition specimen CD.*

A, full-sized stud; *B*, half-sized stud; *C*, floor plate; *D*, top plate; *E*, plywood wallboard.

grooves on the upper surface. The ends were parallel and beveled 1 in. The center stud was fastened to the floor plate by one 8d common nail driven through the floor plate into the stud. Each of the two outer full-sized studs was fastened to the floor plate by two pieces of box strapping which passed through two ¾-in. diam holes in the floor plate, and were fastened to each edge of the stud by two 3d lath nails.

Top plate.—The top plate, *D*, was spruce, 1 by 2 11/16 in., 4 ft 1 in. long, with two grooves on the lower surface. The ends were parallel and beveled 1 in. The top plate was fastened to the center stud by one 6d common nail driven through the top plate into the stud, and to the two outer full-sized studs by a piece of box

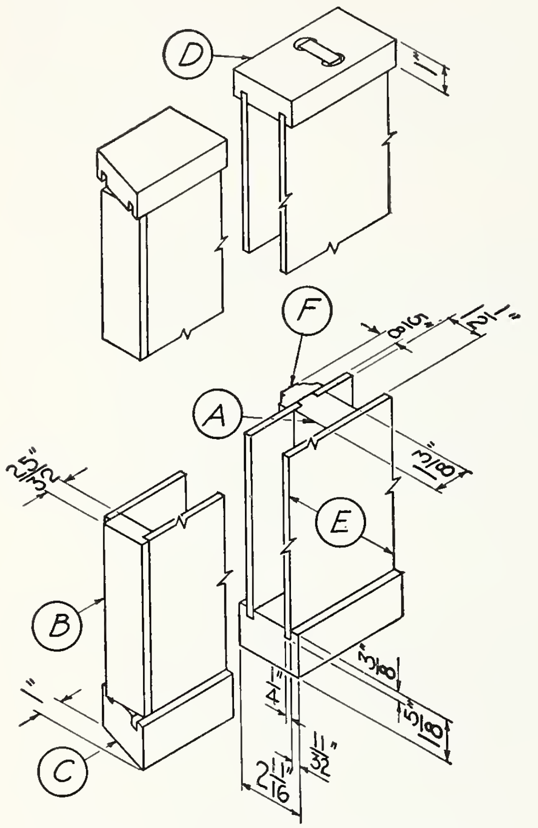


FIGURE 24.—*Details of partition specimen CD.*

A, full-sized stud; *B*, half-sized stud; *C*, floor plate; *D*, top plate; *E*, plywood wallboard; *F*, batten.

strapping passing through two ¾-in. diam holes in the top plate. The box strapping was fastened to each edge of the stud by two 3d lath nails.

Plywood wallboard.—The wallboard, *E*, was ¼-in. Douglas-fir plywood, 8 ft ⅛ in. high and either 1 ft 11¾ in. or 11⅝ in. wide. The boards fitted into the grooves in the floor plate and top plate and into the recesses in the full-sized studs and half-sized studs. One face consisted of two of the wide pieces of wallboard with a vertical joint on the center stud. The other face consisted of one of the wide pieces and two of the narrow pieces with vertical joints on the outer full-sized studs. The wallboard was fastened to the recesses in the full-sized studs and to both sides of the half-sized studs by 3d lath nails, spaced about 5 in., and to the other side of the full-sized studs by blind fasteners, spaced about 12 in. Each fastener was attached to the stud by a 3d lath nail driven through the slot in the fastener. The grain of the outer plies of the wallboard was vertical.

Battens.—The battens, *F* (astragal molding), were ⅝ by 1¾ in., 7 ft 11⅝ in. long, with the exposed face cut to an O-gee-and-fillet mold. They were placed at the joints between the plywood wallboard and the full-sized studs, over the recessed edges of the studs, and fastened with 4d box nails, spaced 10 in.

(*b*) *Comments*

Construction *CD* is a nonload-bearing partition, such as a closet partition. It is designed for ease in assembly, and can be taken apart and reassembled if a change of location is desired. The floor plate and top plate are fastened to the floor and ceiling, respectively, and the plywood wallboard and studs are placed in position alternately.

2. CONCENTRATED LOAD

The results of the concentrated-load tests on partition specimens *CD–P1*, *P2*, and *P3* are shown in table 6 and in figure 25.

TABLE 6.—*Structural properties, partition CD*

[Weight, 2.10 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*
Concentrated	One face	*P1*				550
		P2				450
		P3				440
	Average					480
Impact	One face; span, 7 ft 6 in	*I1*	4.5	4.5	7.5	
		I2	4.5	4.0	7.5	
		I3	4.5	4.0	7.0	
	Average		4.5	4.2	7.3	

The concentrated loads were applied to the plywood wallboard midway between full-sized studs and from 2 to 2½ ft from one end of the specimen. At the maximum load each of the

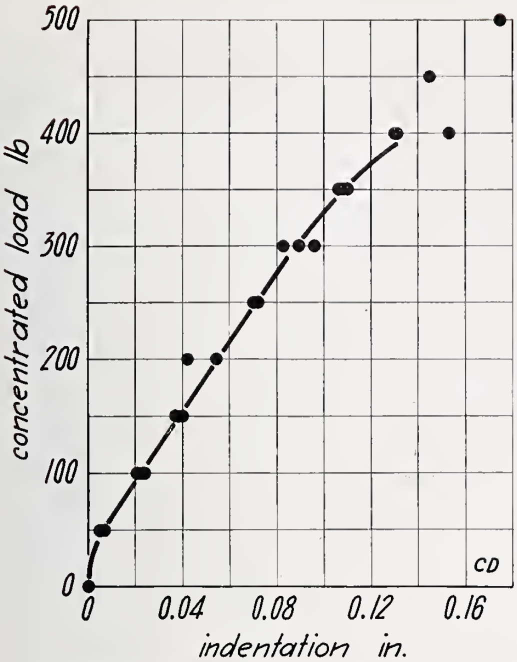


FIGURE 25.—*Concentrated load on partition CD.*

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

specimens failed by punching of the disk through the wallboard.

3. Impact Load

Partition specimen *CD–I3* during the impact test is shown in figure 26. The results for partition specimens *CD–I1, I2,* and *I3* are shown in table 6 and in figure 27.

The impact loads were applied to one face of the specimens, the sandbag striking the center batten and the wallboard. On specimen *I1* at a drop of 3.5 ft the plywood wallboard of the face struck separated from the stud under the center batten. After the 4-ft drop the battens on the opposite face were loose, and at the 4.5-ft drop both faces failed by complete separation of the wallboard from the studs and opening of the joints under the battens. At a drop of 6.5 ft two full-sized studs and one half-sized stud ruptured and the floor plate and the top plate split. At the maximum drop the remaining studs ruptured and the specimen broke in two along the center stud. On specimens *I2* and *I3* at drops of 4 ft the face not struck failed by opening of the joint under one batten, and at drops of 4.5 ft the face struck failed by opening of the joint under the center batten. In specimen *I2* at a drop of 5 ft the center stud ruptured, at a drop of 5.5 ft one outer full-sized stud ruptured, and at the maximum drop the specimen broke in two and the top plate separated from the studs. In specimen *I3* at a drop of 5.5 ft the center stud ruptured, at a drop of 6 ft the two outer full-sized studs ruptured, and at the maximum drop the specimen broke in two.

VIII. FLOOR *CE*

1. Sponsor's Statement

(*a*) *Description*

Floor *CE* was a wood plank-and-joist construction having wood flooring on the upper face.

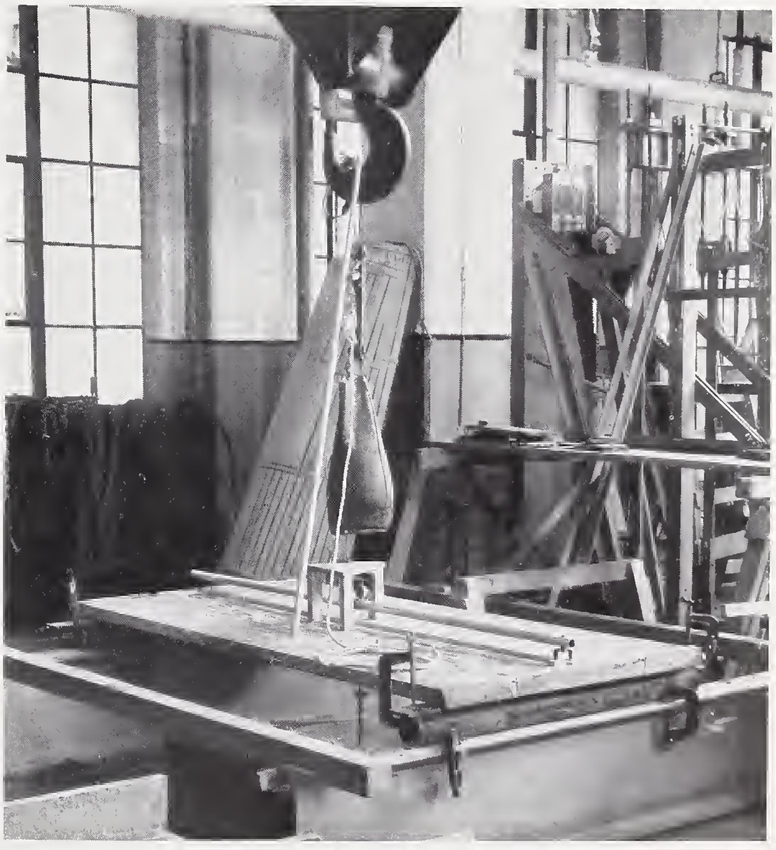


FIGURE 26.—*Partition specimen CD–I3 during impact test.*

The price of this construction in Washington, D. C., as of July 1937, was \$0.385/ft^2.

The floor specimens, shown in figure 28, were 12 ft 6 in. long, 4 ft 0 in. wide, and 6$^5/_{32}$ in. deep. Each specimen consisted of six specially edge-

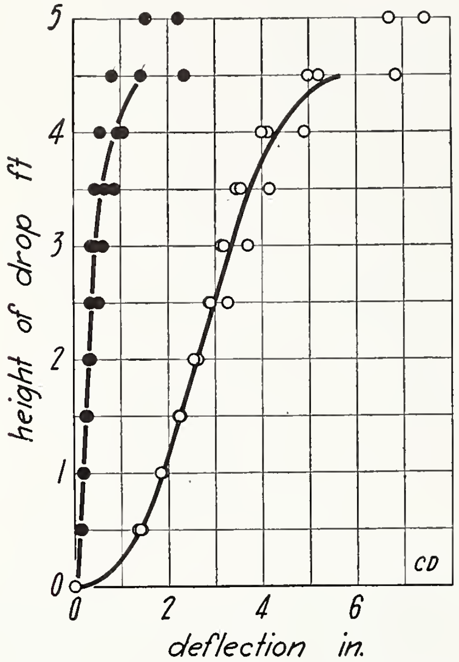


FIGURE 27.—*Impact load on partition CD.*

Height of drop-deflection (open circles) and height of drop-set (solid circles) results for specimens *CD-11*, *12*, and *13* on the span 7 ft 6 in.

matched planks, *A*, two full-sized joists, *B*, two half-sized joists, *C*, and end members, *D*. The upper face consisted of flooring, *E*. The underside and the ends of the specimen were covered with one coat of lead-and-oil paint applied with a brush.

Planks.—The planks, *A*, were spruce, 1¾ by 7$^9/_{16}$ in. (nominal 2 by 8 in), 12 ft 6 in. long. One edge of the plank was recessed ⅞ by ⅜ in., and the opposite edge was matched, as shown in figure 29.

Joists.—The full-sized joists, *B*, were spruce, 1⅝ by 5⅝ in. (nominal 2 by 6 in.), 12 ft 6 in. long, grooved ⅞ by ⅜ in. on two sides, ⅞ in. below the edge. The projecting edge of each plank fitted into the groove in the adjacent joist. Sixpenny box nails, spaced 1 to 2 ft, were driven horizontally through the joist at the groove into the projecting edge of the plank on one side. In some specimens the planks on both sides of a joist were fastened to the joist by corrugated fasteners spaced about 1 ft 6 in. driven from the upper surface of the specimen. The projecting edges of adjacent planks matched and were joined by corrugated fasteners spaced about 1 ft 6 in., crossing the joint and driven from the under side.

The half-sized joists, *C*, were spruce, $^{25}/_{32}$ by 5⅝ in. (nominal 1 by 6 in.), 12 ft 6 in. long, grooved ⅞ by ⅜ in. on one side, ⅞ in. below the upper edge. The projecting edge of the outer plank fitted into the groove in the half-sized joist and was fastened by 6d box nails, 6d common nails, 1½-in. plasterboard nails, or 6d shingle nails. The nails were spaced from 1 to 2 ft and were driven through the half-sized joists into the plank. A strip of perforated hanger iron was fastened along the ends of the planks and extended around the corners of the specimen about 1 in., as shown in figure 28. It was fastened to the half-sized joists and to each plank by two 1½-in. plasterboard nails.

End members.—The end members, *D*, were spruce, 1⅝ by 3⅝ in. (nominal 2 by 4 in.), 1 ft 2⅜ in. long, grooved 2½ by ½ in. on one side. The members were inserted between joists at the ends of the specimen and were fastened to the planks by from three to five 6d common nails or 10d common nails toenailed from the groove into the planks. The outer end members were fastened to the half-sized joists by strips of box strapping, about 4 in. long, bent around the bottom edge of the half-sized joist and fastened to the half-sized joist and the end member by either a 3d lath nail or a ¾-in. roofing nail.

Flooring.—The flooring, *E*, was shortleaf pine and consisted of 43 tongued-and-grooved lines of flooring, $^{25}/_{32}$ by 3¼ in. The strips of flooring were blind-fastened to the planks by either 6d shingle nails or 6d cut flooring nails. There were from four to six nails to each line spaced along its length.

(*b*) *Comments*

Planks and joists are available in soft woods and in thicknesses ranging from 1¼ to 3 in. In a house of this construction the first-story floor joists rest on the foundation plate and are fastened by nails to the plate and to the wall planks. Second-story joists rest on a wood ribbon nailed to the wall planks. The ends of the joists are notched at the lower edge and extend in against the recessed wall planks, where they are nailed. If the joists rest on an interior support, the ends of abutting joists are spliced and fastened by nails or bolts.

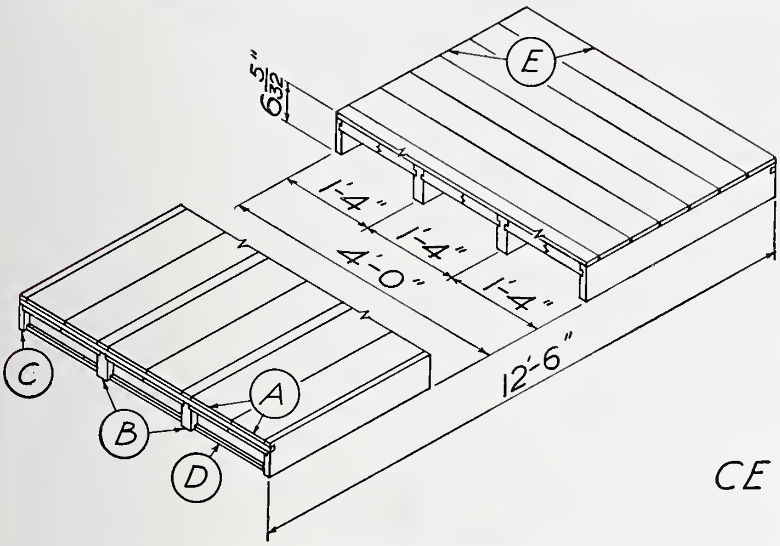


Figure 28.—*Floor specimen CE.*

A, planks; *B*, full-sized joists; *C*, half-sized joists; *D*, end members; *E*, flooring.

Finish floors of various kinds may readily be applied to the floor planks. The underside of the floor may be finished with paint, wallboard, or lath and plaster.

This floor construction also is intended for attic floors and roofs if the distance between supports does not exceed 13 ft.

2. Transverse Load

Floor specimen *CE–T2* under transverse load is shown in figure 30. The results for floor specimens *CE–T1*, *T2*, and *T3* are shown in table 7 and in figure 31.

In specimen *T1* at a load of 177 lb/ft² the half-sized joists split at middepth both between the loading rollers and from one end to midspan. At a load of 211 lb/ft² the two inner joists ruptured at knots near midspan, and at the maximum load they ruptured completely. As the deflection increased all the planks ruptured at midspan. In specimen *T2* at a load of 135 lb/ft² both half-sized joists split at middepth along the entire length of the specimen. At a load of 150 lb/ft² one full-sized joist ruptured under both loading rollers, and at 175 lb/ft² the other full-sized joist split the entire length of the specimen along the groove in the joist. At the maximum load the full-sized joist split and four planks ruptured between the loading rollers. In specimen *T3* at a load of 175 lb/ft² the half-sized joists ruptured at midspan, at a load of 200 lb/ft² both inner joists ruptured at or between the loading rollers, and at the maximum load two planks ruptured at or between the loading rollers. In all specimens the flooring was undamaged, though in specimen *T1* it had separated noticeably from the planks.

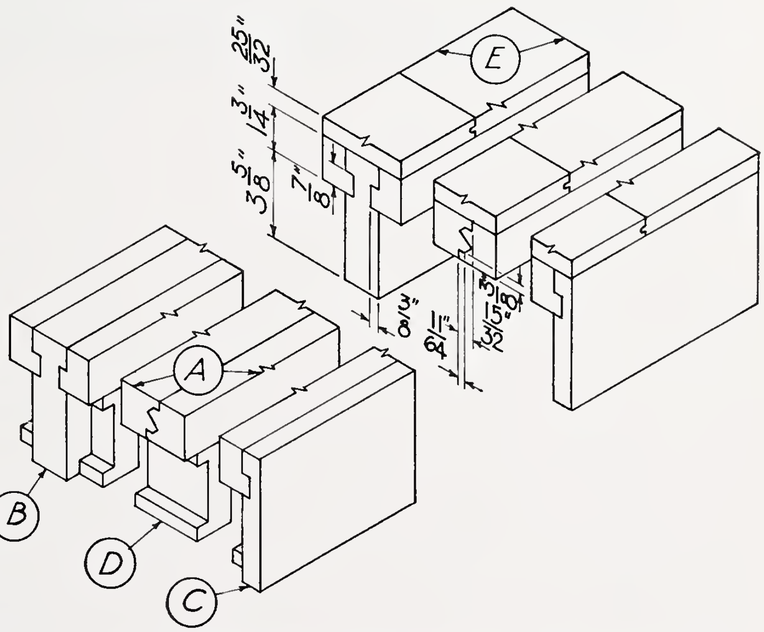


Figure 29.—*Details of floor specimen CE.*

A, planks; *B*, full-sized joist; *C*, half-sized joist; *D*, end member; *E*, flooring.

3. Concentrated Load

The results for floor specimens *CE–P1*, *P2*, and *P3* under concentrated load are shown in table 7 and in figure 32.

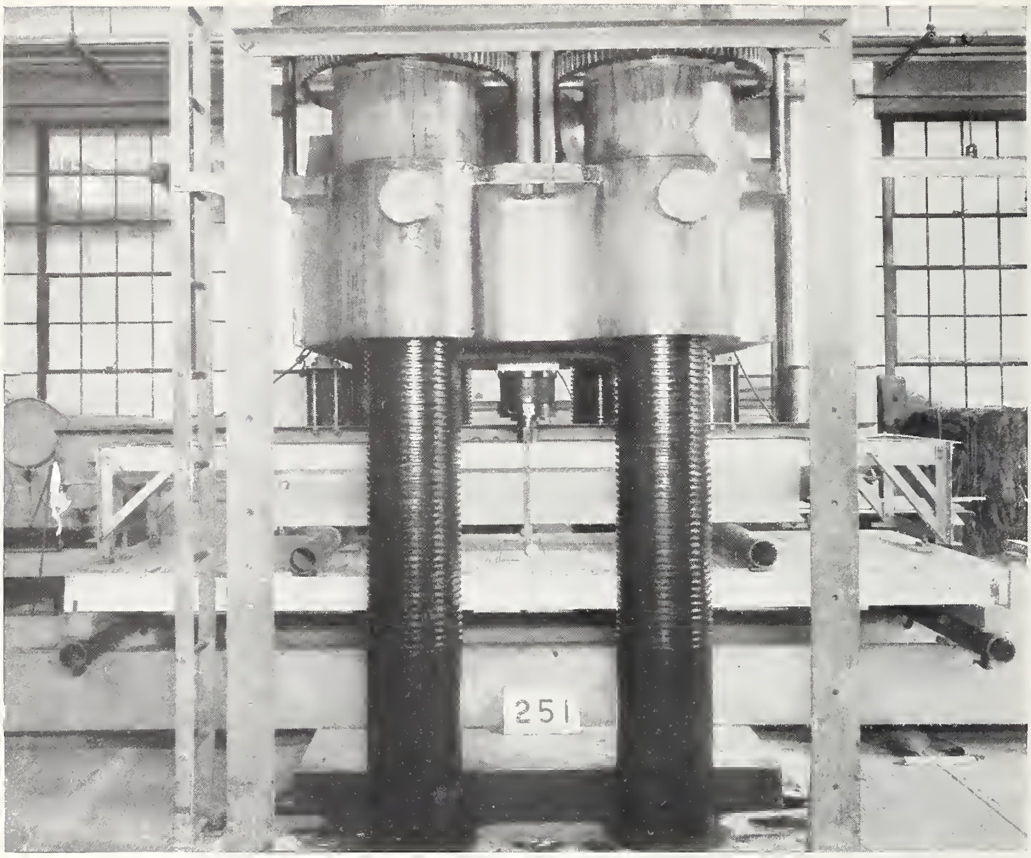


Figure 30.—*Floor specimen CE–T2 under transverse load.*

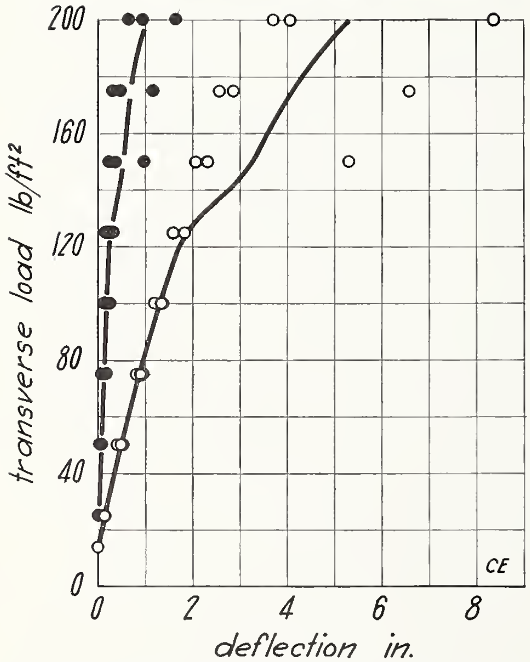


Figure 31.—*Transverse load on floor CE.*

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

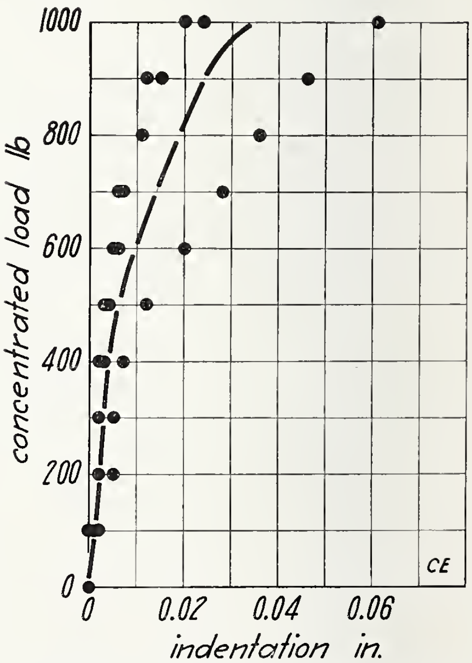


Figure 32.— *Concentrated load on floor CE.*

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

TABLE 7.—*Structural properties, floor CE*

[Weight, 7.80 lb/ft²]

Load	Load applied	Specimen designation	Maximum height of drop	Maximum load
			ft	*lb/ft²*
Transverse	Upper face; span, 12 ft 0 in.	*T1*		214
		T2		237
		T3		235
	Average			229
				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*	[a] 10.0	
		I2	[a] 10.0	
		I3	[a] 10.0	
	Average		[a] 10.0	

[a] Test discontinued. Specimens did not fail.

The concentrated loads were applied between full-sized joists at the corner of an end joint in the flooring either 6 ft or 2 ft from one end of the specimen. The indentations after a load of 1,000 lb had been applied were 0.024, 0.020, and 0.061 in. for specimens *P1*, *P2*, and *P3*, respectively, and no other effect was observed.

4. IMPACT LOAD

The results for floor specimens *CE–I1*, *I2*, and *I3* under impact load are shown in table 7 and in figure 33.

The impact loads were applied to the upper face, the sandbag striking the flooring between the full-sized joists. The sets after a drop of 10 ft were 0.034, 0.102, and 0.065 in. for specimens *I1*, *I2*, and *I3* respectively, and no other effect was observed.

IX. ADDITIONAL COMMENTS BY SPONSOR

Three houses have been built embodying these constructions except that in one the floor planks were tongued and grooved.

The roof construction is similar to the floor construction for both flat or sloping roofs. If the roof is covered with tiles or shingles, they are laid on 1-in. furring strips. For sloping roofs the rafters extend beyond the wall line and are notched to fit the top plate. A ridge rafter is not required; the ends of the planks are mitered and nailed. Ceilings may be of conventional construction.

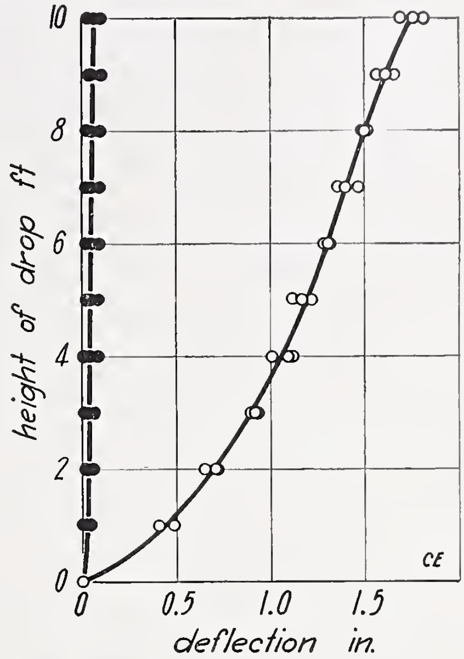


FIGURE 33.—*Impact load on floor CE.*

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

The description and drawings of the specimens were prepared by E. J. Schell, G. W. Shaw, and T. J. Hanley of the Bureau's Building Practice and Specifications Section, under the supervision of V. B. Phelan.

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.

X. SELECTED REFERENCES

American Builder **60**, No. 12, 34–35 (1938).

American Lumberman **3133**, 35 (1938); **3138**, 24–25 (1938).

Architectural Forum **69**, 80 (1938); **70**, 246 (1939).

Architectural Record **86**, 88, 93 (1939).

WASHINGTON, August 5, 1939.