U. S. DEPARTMENT OF COMMERCE

BUILDING MATERIALS AND STRUCTURES

REPORT BMS89

Structural Properties of "Precision-Built, Jr." (Second Construction) Prefabricated Wood-Frame Wall Construction Sponsored by the Homasote Co.

by

W. GAIL HOBACK

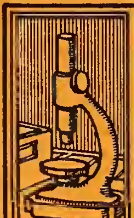
HERMAN L. WEISS, *and*

VINCENT B. PHELAN

with the collaboration of the

Forest Products Laboratory

NATIONAL BUREAU OF STANDARDS



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Forest Products Laboratory, Forest Service, United States Department of Agriculture

ISSUED JULY 17, 1942

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.

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Foreword

This report is one of a series issued by the National Bureau of Standards on the structural properties of constructions intended for low-cost houses and apartments. These constructions were sponsored by 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 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 materials and method of fabrication. The Bureau is responsible for the testing of the specimens and the preparation of the report.

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

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 its merits for 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 "Precision-Built, Jr." (Second Construction) Prefabricated Wood Frame Wall Construction Sponsored by the Homasote Co.

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ABSTRACT

For the program on the determination of the structural properties of low-cost house constructions, the Homasote Co., Trenton, N. J., submitted 18 specimens representing a wall construction consisting of a wood frame with "Homasote" insulating fiberboard on the inside face and bevel siding on the outside face.

The specimens were subjected to compressive, transverse, concentrated, impact, and racking loads, for each of which three like specimens were tested. The transverse, concentrated, and impact loads were applied to both faces of the specimens.

The deformation under load and the set after the load was removed were measured for each increment of load. The results are presented in graphs and tables.

I. INTRODUCTION

To provide technical facts on the performance of constructions for 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 BMS1, Research on Building Materials and Structures for Use in Low-Cost Housing.

To determine the strength of house constructions in the laboratory, standardized methods were developed for applying loads simulating the loads to which a completed house is subjected. Included in this study were masonry and wood constructions of types which have been extensively used in this country for houses and whose behavior under widely different service conditions is well 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 one element of a house sponsored by one of the manufacturers in the building industry. The wall specimens were subjected to compressive, transverse, concentrated, impact, and racking loads simulating the loads to which walls are subjected. In actual service compressive loads on the walls of a one-story house are produced by the weight of the roof and by snow and wind loads; transverse loads are produced by wind, concentrated and impact loads by accidental contact with heavy objects, and racking loads by the action of the wind on adjoining walls.

The deflection and set under each increment of load were measured, because the suitability of a construction depends not only on its resistance to deformation when loads are applied but also on its ability to return to its original size and shape when the loads are removed.

II. SPONSOR AND PRODUCT

The Homasote Co. sponsored BMS48, Structural Properties of "Precision-Built" Frame Wall and Partition Constructions, and BMS72, Structural Properties of "Precision-Built, Jr." Prefabricated Wood-Frame Wall Construction. The present report, sponsored by the same organization, gives the results on "Precision-Built, Jr." (Second Construction).

The wall construction consists of a wood frame with "Homasote" insulating fiberboard fastened to the inside face by glue and nails and wood bevel siding fastened to the outside face by nails.

III. SPECIMENS AND TESTS

The wall construction was assigned the symbol *DQ*, and the individual specimens were assigned the designations given in table 1.

TABLE 1.—*Specimen designations, wall DQ*

Specimen designation	Load	Load applied
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	Top plate.

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

Except as mentioned below, the specimens were tested in accordance with BMS2. That report also gives the requirements for specimens and describes the presentation of the results of the tests, particularly the load-deformation graphs.

For the compressive load the thickness of the specimens was taken as the thickness of the structural portion, that is, the thickness of the frame. The compressive load was applied along a line parallel to the faces and at one-third the thickness of the frame from the inside surface of the studs.

Under compressive load, the shortening of the entire specimen may not be proportional to the value obtained from compressometers attached to the specimen over only a portion of its height; therefore, the shortenings and the sets were measured with compressometers attached to the plates through which the load was applied, not attached to the specimen as described in BMS2.

The indentation under concentrated load and the set after the load was removed were measured, not the set only, as described in BMS2. The apparatus is shown in figure 1.

The load was applied to a steel disk, *A*, to which the crossbar, *B*, was rigidly attached, and was measured by means of the dynamometer, *C*. Two stands, *D*, rested on the face of the specimen, one over each inner stud. Each stand supported a dial micrometer, *E*, the spindle of which was in contact with the crossbar 8 in. from the disk. The micrometers were graduated to 0.001 in., and readings were recorded to the nearest division. The initial reading (average of the micrometer readings) was observed under the initial load, which included the weight of the disk and dynamometer. A load was applied to the disk, and the average of the micrometer readings

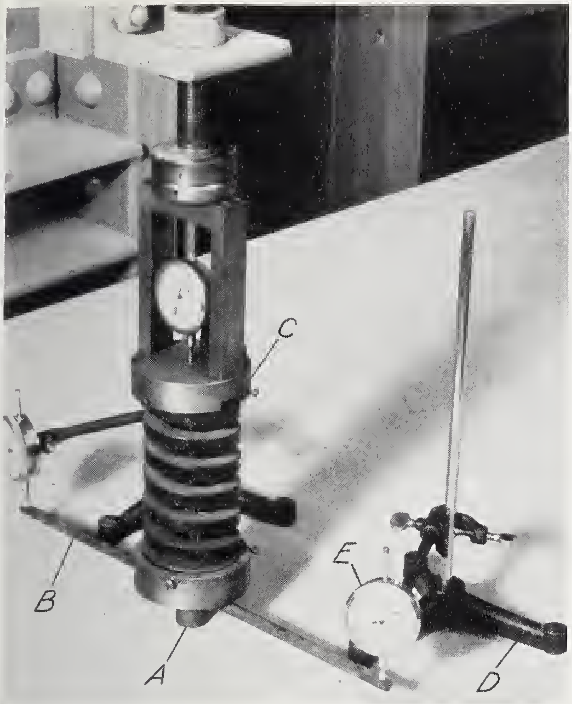

FIGURE 1.—*Apparatus for concentrated-load test.*

A, steel disk; *B*, cross bar; *C*, dynamometer; *D*, stand; *E*, dial micrometer.

minus the initial reading was taken as the depth of the indentation under load.

The deflections and sets under the impact load were measured by means of two deflectometers and two set gages, not one of each as described in BMS2. The deflectometers were placed in contact with the unloaded face of the specimen at midspan, one under each outer stud, and the set gages rested on the loaded face, one over each outer stud. The readings, therefore, were not affected by local deformations of the faces.

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. The channel rested on two steel plates, ½ in. thick and 4 in. square, on top of the specimen, with the steel angle extending downward in the plane of the specimen. Two pins passed snugly through the web of the channel into the top plate of the specimen. The floor plate was in contact with the stop, to which a dial micrometer was attached. The micrometer spindle was in contact with the steel angle of the deformeter. The gage length (distance from the top of the specimen to the center of the spindle) was 7 ft. 10 in. The micrometer was graduated to 0.001 in., and readings were recorded to the nearest division. The deformeter was used instead of the taut-wire mirror-scale device described in BMS2.

The tests were begun January 22, 1942, and completed January 30, 1942. The sponsor's representative witnessed the tests.

IV. MATERIALS

Unless otherwise stated, the information on materials was obtained from the sponsor and from inspection of the specimens. The Forest Products Laboratory identified the species of the wood. The Paper Section of the National Bureau of Standards determined the physical properties of the fiberboard, and the Engineering Mechanics Section determined the moisture content of the wood and fiberboard.

1. WOOD

Framing.—The wood for the framing was identified as Douglas fir, *Pseudotsuga taxifolia*, No. 1 common, S4S (surfaced four sides). Sizes 1⅝ by 2⅝ in. (nominal 2 by 3 in.).

Bevel siding.—Western red cedar, 9/16 by 3/16 by 7½ in., select, grade *B* or better.

Spacer blocks.—Identified as balsam fir, No. 2 common, 25/32 by 1⅝ in. (nominal 1 by 2 in.), S4S.

After each specimen was tested, the fiberboard face was removed to expose the framing and a sample of the bevel siding, spacer block, and framing was taken for identification of the species and for determination of the moisture content. Photographs were made of each specimen showing the failures and the character of the wood in the framing. Typical specimens are shown in figures 2 and 3.

A spacer block and the sample of bevel siding from each specimen were dried to constant weight at 212° F and the moisture content was calculated. The results are given in table 2.

TABLE 2.—*Moisture content of wood and fiberboard*

[Determined on the day the wall specimen was tested]

Material	Moisture content [a]		
	Minimum	Maximum	Average
	Percent	*Percent*	*Percent*
Bevel siding, western red cedar	4	8	6
Spacer blocks, balsam fir	4	8	6
Framing, Douglas fir	6	18	12
Fiberboard	4	7	5

[a] Based on weight when ovendry.

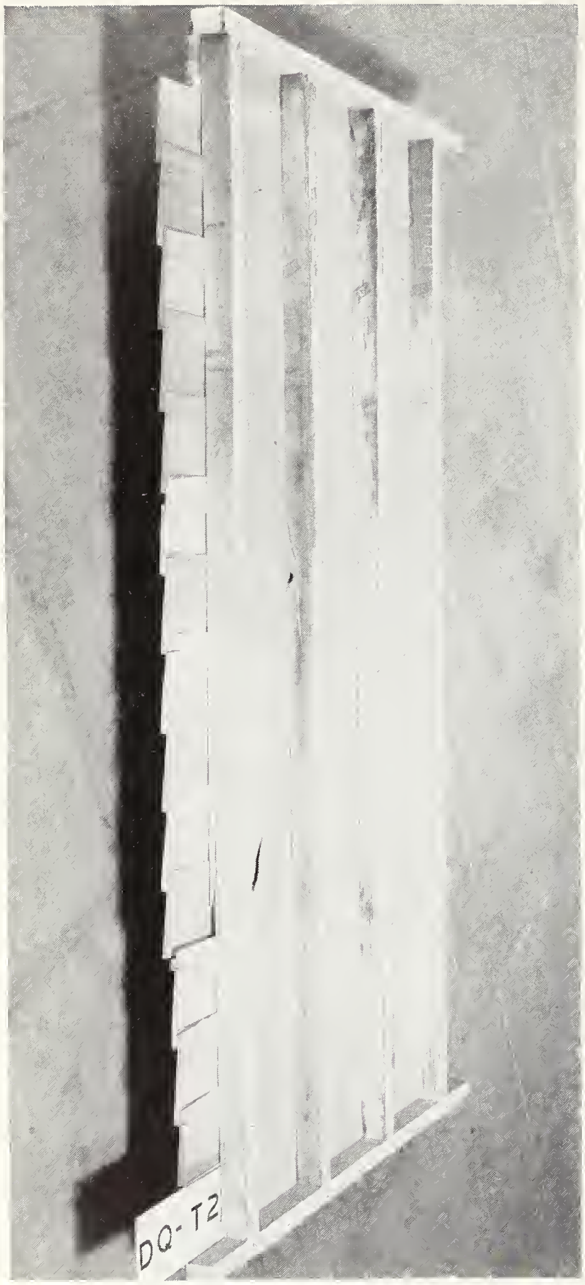

FIGURE 2.—*Wall DQ.*

Typical 4-foot specimen.

For each specimen, readings were taken with an electric moisture meter on each piece of framing. To calibrate the moisture meter for Douglas fir, moisture determinations were made on one piece of framing from each specimen by drying it to constant weight at 212° F. From these determinations the correction to be added algebraically to the meter readings was −0.65. Values of the moisture content given in table 2 were obtained by applying this correction to the average of the meter readings and rounding the result to the nearest whole percent.

2. Insulating Fiberboard

The insulating fiberboard was "Homasote," 15/32 in. thick, made from vegetable fibers derived largely from waste paper. The fibers are sized with rosin and waxes to increase water resistance and then felted into boards.

The physical properties, given in table 3 were determined on undamaged samples taken from the wall specimens after testing. The linear expansion, tensile strength, transverse strength and deflection, and water absorption were determined in accordance with Federal Specification LLL–F–321a, Fiberboard; Insulating. For these properties the board complied with requirements for Class A. The terminal conductivity failed to comply with the requirements for Class A, for which the maximum value is 0.36 (Btu/hr ft^2) (°F/in.).

TABLE 3.—*Physical properties of insulating board, 15/32 in. thick*

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

Property	Value
Tensile strength:	
Machine direction lb/in.^{2}	496
Cross direction lb/in.^{2}	480
Transverse strength: [a]	
Machine direction lb	25
Cross direction lb	23
Deflection at rupture:	
Machine direction in	0.73
Cross direction in	.82
Linear expansion for 45 percent change in relative humidity:	
Machine direction percent	.25
Cross direction percent	.35
Nail-holding strength:	
Machine direction lb	101
Cross direction lb	95
Density, after drying 24 hours at 160° F lb/ft^3	23.3
Air permeability (ft^3/hr ft^2)/(lb/in.^{2})	31
Water absorption, by volume percent	2.5
Thermal conductivity (Btu/hr ft^2)/(°F/in.)	[b] 0.43

[a] Span, 12 in.; width of specimens, 3 in.
[b] Value given by sponsor.

The moisture content of the fiberboard was determined on one sample from each specimen by drying at 212° F until the weight was constant. The result is given in table 2.

3. Sheathing Paper

The sheathing paper was red paper, rosin-sized, weight 30 lb/500 ft^2; width 3 ft 0 in.

FIGURE 3.—*Wall DQ.*

Typical 8-foot specimen.

4. NAILS

A description of the steel-wire nails is given in table 4.

TABLE 4.—*Description of steel-wire nails*

Type	Size	Length	Steel Wire Gage	Diameter	Finish	Nails per pound
	Penny	*in.*	*No.*	*in.*		
Common	5	1¾	12½	0.0985	Zinc coated	251
Do	10	3	9	.1438	Bright	69
Do	16	3½	8	.1620	do	49
Special Homasote [a]		1⁹⁄₁₆	16	.0625	Cement coated	744

[a] 5/32 in. thin flat head, long diamond point.

5. GLUE

Casein glue, grade A, ground. Formula: casein, 65 percent; lime, 15 percent; and dispersing agents and secret ingredients. One part of glue was mixed with one part of water, by volume, to which were added 2 ounces of kerosene per pound of dry glue. The glue complied with United States Army Specification 3-152-A and United States Navy Specification 52G8b. I. F. Laucks Inc., "Lauxein 888."

V. WALL *DQ*

1. SPONSOR'S STATEMENT

Wall *DQ* was a wood-frame construction

having wood bevel siding on the outside face and insulating fiberboard on the inside face, fastened by both glue and nails. The specimens were not painted.

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

(a) *Four-Foot Specimens*

The 4-ft specimens, shown in figure 4, were

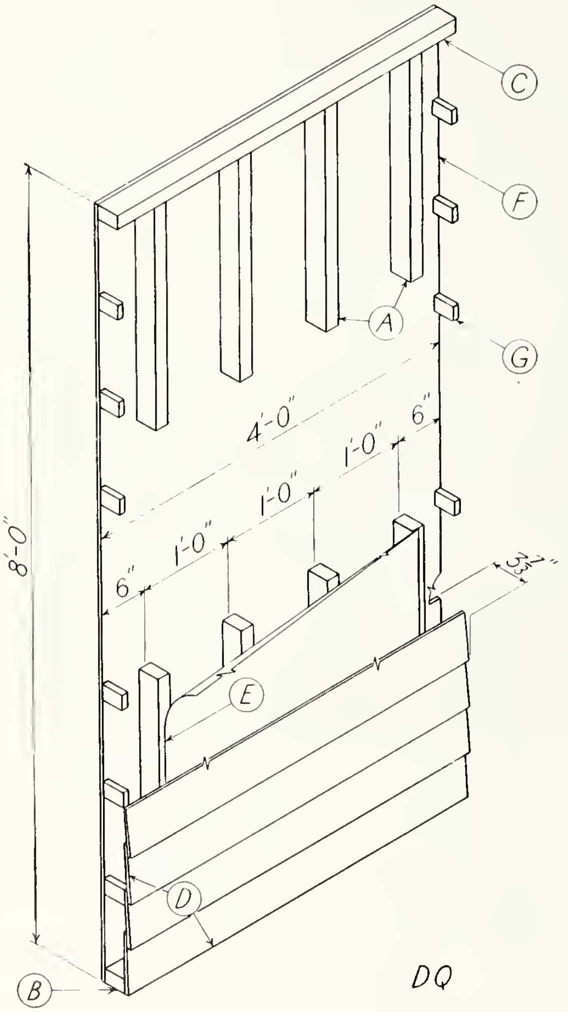

FIGURE 4.—*Four-foot specimen DQ.*
A, studs; *B*, floor plate; *C*, top plate; *D*, bevel siding; *E*, sheathing paper; *F*, inside face; *G*, spacer blocks.

8 ft 0 in. high, 4 ft 0 in. wide, and 3⅞ in. thick. Each was a wood frame to which faces were fastened. The frame consisted of four studs, *A*, fastened to a floor plate, *B*, and a top plate C. The outside face was bevel siding, *D*, over sheathing paper, *E*. The inside face was one sheet of insulating fiberboard, *F*, The edges of the faces were connected by wood spacer blocks *G*.

Studs.—The studs, *A*, were Douglas fir, 1⅝ by 2⅝ in. (nominal 2 by 3 in.), 7 ft. 8¾ in. long, spaced 1 ft. 0 in. on centers. Each stud was fastened to the floor plate and the top plate by two 16d common nails extending through each plate and into the stud.

Floor plate and top plate.—Both floor plate, *B*, and top plate, *C*, were Douglas fir, 1⅝ by 2⅝ in. (nominal 2 by 3 in.), 4 ft. 0 in. long.

Bevel siding.—The bevel siding, *D*, was 16 pieces of western red-cedar siding, $^9\!/_{16}$ by $^3\!/_{16}$ by 7½ in., 4 ft 0 in. long, laid 6 in. to the weather. The siding was fastened at each stud by one 5d zinc-coated common nail extending through the overlapping edges and into the stud.

Sheathing paper.—The sheathing paper, *E*, was one piece, 3 ft 0 in. wide and 8 ft 0 in. long, laid longitudinally over the studs and equidistant from each edge of the specimen. The paper was fastened to the top plate and floor plate by two or three "Homasote" nails at each end before the siding was applied.

Insulating fiberboard.—The insulating fiberboard, *F*, was $^{15}\!/_{32}$ in. thick, 8 ft. 0 in. high, and 4 ft. 0 in. wide, fastened to the floor plate, top plate, and studs by both glue and nails. The glue was liberally applied to the studs and plates by a roller. The nails were special "Homasote" nails spaced about 6 in. along the plates and 10 in. along the studs.

Spacer blocks.—The spacer blocks, *G*, were balsam fir, $^{25}\!/_{32}$ by 1⅝ in., 2⅝ in. long, spaced 1 ft. 0 in. on centers, fastened by three "Homasote" nails, one extending through the bevel siding and two through the insulating fiberboard.

(b) *Eight-Foot Specimens*

The 8-ft. specimens, shown in figure 5, were 8 ft. 0 in. high, 8 ft. 0 in. wide, and 3⅞ in. thick. The specimens were similar to the 4-ft.

specimens except for the following differences: There were nine studs (not four). Each outer stud was centered 11$\frac{3}{16}$ in. from the adjacent stud. The other seven studs were spaced 1 ft. 0 in. on centers. The bevel siding was 8 ft. 0 in. long. Three pieces of sheathing paper were laid transversely over the studs and lapped 6 in. The insulating fiberboard was 8 ft. 0 in. wide; the nails for fastening the fiberboard to the outer studs were spaced 6 in. (not 10 in.).

2. Compressive Load

Specimen *DQ–C3* under compressive load is shown in figure 6. The results for specimens *DQ–C1*, and *C2*, and *C3* are shown in table 5 and figures 7 and 8.

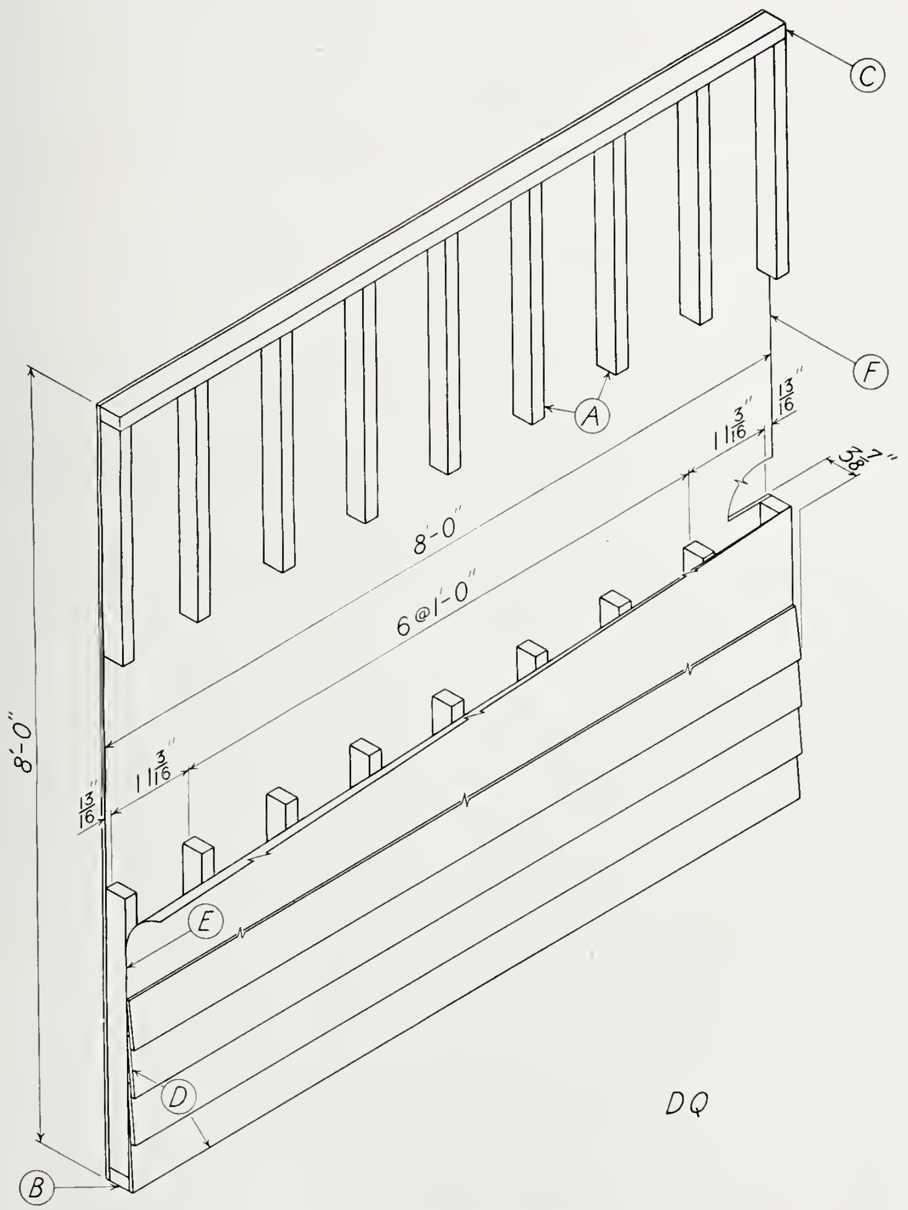

Figure 5.—*Eight-foot specimen DQ.*

A, studs; B, floor plate; *C*, top plate; *D*, bevel siding; *E*, sheathing paper; *F*, inside face.

Table 5.—*Structural properties of wall DQ*

[Weight, based on face area: 2.99 lb/ft²]

Compressive load [a]		Transverse load; span 7 ft. 6 in.		Concentrated load; diameter of disk 1 in.		Impact load; span 7 ft. 6 in.; weight of sandbag 60 lb.		Racking load	
Specimen	Maximum load	Specimen	Maximum load	Specimen	Maximum load	Specimen	Maximum height of drop	Specimen	Maximum load
	[b] *Kips/ft*		*lb/ft²*		*lb*		*ft*		[b] *Kip/ft*
C1	6.73	*T1*	195	*P1*	224	*I1*	3.0	*R1*	0.90
C2	5.52	*T2*	216	*P2*	236	*I2*	2.5	*R2*	.89
C3	5.45	*T3*	195	*P3*	240	*I3*	2.5	*R3*	.82
Average	5.90	Average	202	Average	233	Average	2.7	Average	.87
		T4	220	*P4*	397	*I4*	6.5		
		T5	179	*P5*	420	*I5*	5.5		
		T6	199	*P6*	400	*I6*	6.0		
		Average	199	Average	406	Average	6.0		

[a] Load applied 0.88 in. (⅓ the thickness of the frame) from the inside surface of the studs.

[b] A kip is 1,000 lb.

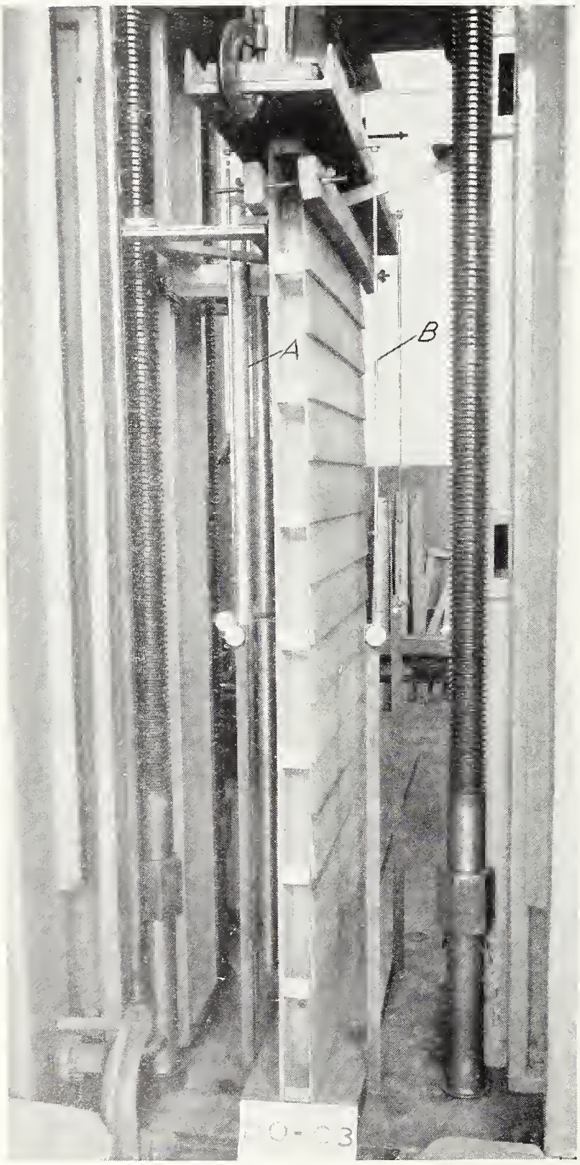

Figure 6.—*Wall specimen DQ-C3 under compressive load.*

A, deflectometer; *B*, compressometer.

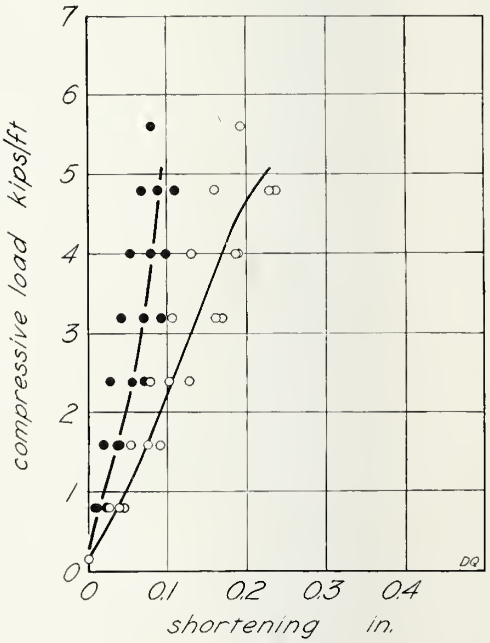

Figure 7.—*Compressive load on wall DQ.*

Load-shortening (open circles) and load-set (solid circles) results for specimens *DQ-C1*, *C2*, and *C3*. The load was applied 0.88 in. (one-third the thickness of the frame) from the inside surface of the studs. The loads are in kips per foot of actual width of specimen.

The speed of the movable head of the testing machine was adjusted to 0.072 in./min.

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

Under the maximum load on each specimen, the insulating fiberboard buckled and separated from the studs at the upper portion of the specimen; the top plates of specimens *C1* and *C2* crushed over the studs at the inside edge. The bottom plate of specimen *C3* crushed under the

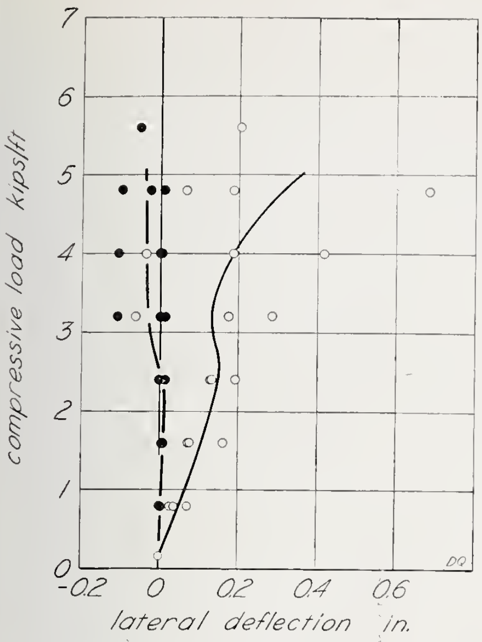

FIGURE 8.—*Compressive load on wall DQ.*

Load-lateral deflection (open circles) and load-lateral set (solid circles) results for specimens *DQ–C1*, *C2*, and *C3*. The load was applied 0.88 in. (one-third tne thickness of the frame) from the inside face of the studs. The loads are in kips per foot of actual width of specimen. The deflections and sets are for a gage length of 7 ft. 6 in., the gage length of the deflectometers.

studs at the outside edge. Under maximum load on each specimen, the studs continued to bend laterally toward the outside face (the face farther from the load line).

3. Transverse Load

Specimen *DQ–T4* under transverse load is shown in figure 9. The results are presented in table 5 and in figure 10 for specimens *DQ–T1*, *T2*, and *T3*, loaded on the inside face, and in table 5 and figure 11 for specimens *DQ–T4*, *T5*, and *T6*, loaded on the outside face.

The speed of the movable head of the testing machine under no load was adjusted to 0.193 in./min.

Under a load of 153 lb/ft ^{2}, one outer stud in specimen *T1* ruptured under a loading roller. In specimen *T3* at a load of 175 lb/ft ^{2}, an outer stud ruptured at a knot near a loading roller, and under a load of 187 lb/ft ^{2}, the other outer stud ruptured at midspan.

Under the maximum load, both outer studs and one inner stud ruptured in specimens *T1* and *T3*. In specimen *T2* one outer stud and the adjacent inner stud ruptured under the maximum load.

Under a load of 170 lb/ft ^{2}, an outer stud of specimen *T5* cracked longitudinally between two knots under a loading roller.

Under the maximum load, one inner stud ruptured in specimens *T4* and *T6*, and in specimen *T5* both outer studs and one inner stud ruptured. The ruptured inner stud in specimen *T4* caused the insulating fiberboard to separate

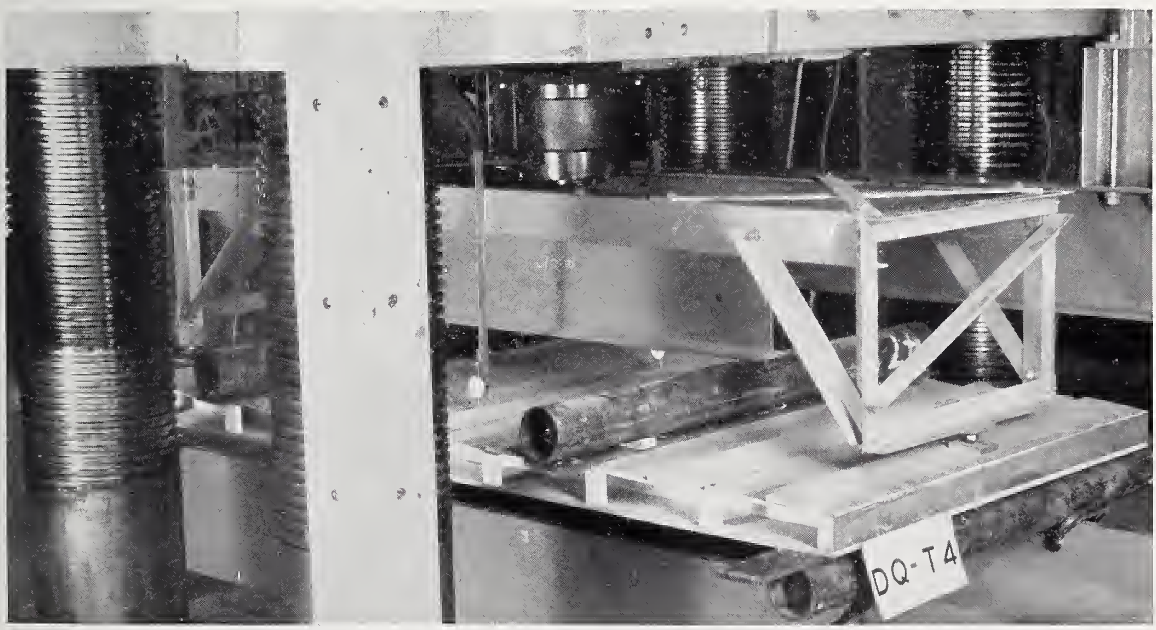

FIGURE 9.—*Wall specimen DQ–T4 under transverse load.*

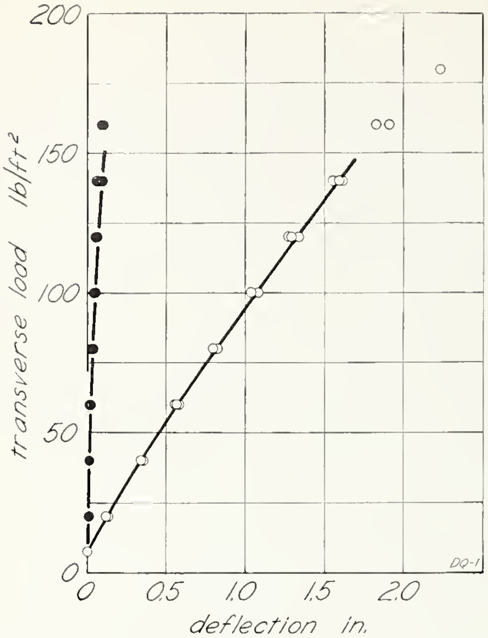

Figure 10.—*Transverse load on wall DQ, load applied to inside face.*

Load-deflection (open circles) and load-set (solid circles) results for specimens *DQ–T1, T2*, and *T3* on the span 7 ft. 6 in. The load (pounds per square foot) is the total load divided by the product of the span and the width of the specimen.

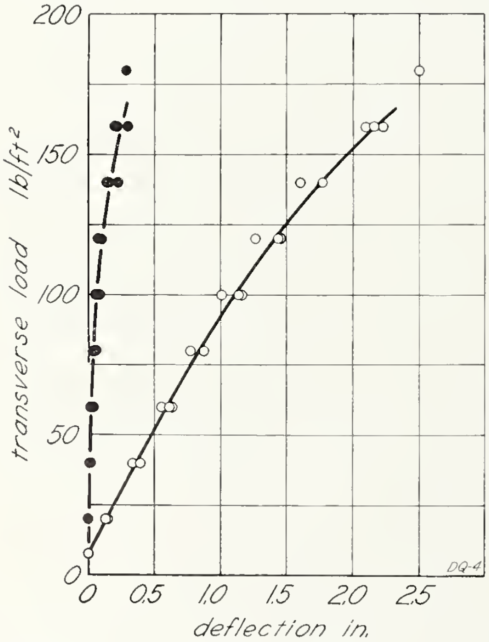

Figure 11.—*Transverse load on wall DQ, load applied to outside face.*

Load-deflection (open circles) and load-set (solid circles) results for specimens *DQ–T4, T5*, and *T6* on the span 7 ft. 6 in. The load (pounds per square foot) is the total load divided by the product of the span and the width of the specimen.

from the studs; the inside faces (fiberboard) of specimens *T5* and *T6* were undamaged.

4. Concentrated Load

The results of the concentrated-load tests are shown in table 5 and in figure 12 for specimens *DQ–P1, P2*, and *P3*, loaded on the inside face, and in figure 13 for specimens *DQ–P4, P5*, and *P6*, loaded on the outside face.

The concentrated load was applied midway between two studs and 17 in. from one end on specimens *DQ–P1, P2*, and *P3* and 21 in. from one end on *DQ–P4, P5*, and *P6*. Under the maximum load on specimens *DQ–P1, P2*, and *P3*, the disk punched through the fiberboard and on specimens *DQ–P4, P5*, and *P6*, punched through the bevel siding.

5. Impact Load

Specimen *DQ–I1* during the impact test is shown in figure 14. The results are given in table 5 and in figure 15 for specimens *DQ–I1, I2*, and *I3*, loaded on the inside face; in figure 16 for specimens *DQ–I4, I5*, and *I6*, loaded on the outside face. The impact loads were applied to the center of the specimen, the sandbag striking the face midway between the two inner studs.

In specimens *I1, I2*, and *I3* the fiberboard fractured under the sandbag at a drop of 1.5 ft, and at a drop of 2.0 ft. the sandbag broke through the fiberboard. At the maximum drop the bevel siding on specimens *I1, I2*, and *I3* ruptured.

At a drop of 3.0 ft, 4.5 ft., and 2.0 ft for specimens *I4, I5*, and *I6* respectively, the fiberboard separated from the outer studs at midspan. The bevel siding ruptured under the sandbag on specimens *I4* and *I6* at a drop of 4.5 ft and on specimen *I5* at a drop of 4.0 ft. At the maximum drop for specimens, *I4, I5*, and *I6*, the fiberboard ruptured under the sandbag.

6. Racking Load

Specimen *DQ–R1* under racking load is shown in figure 17. The results on specimens *DQ–R1, R2*, and *R3* are given in table 5 and in figure 18.

The racking loads were applied to the top plate, and the stop was in contact with the floor

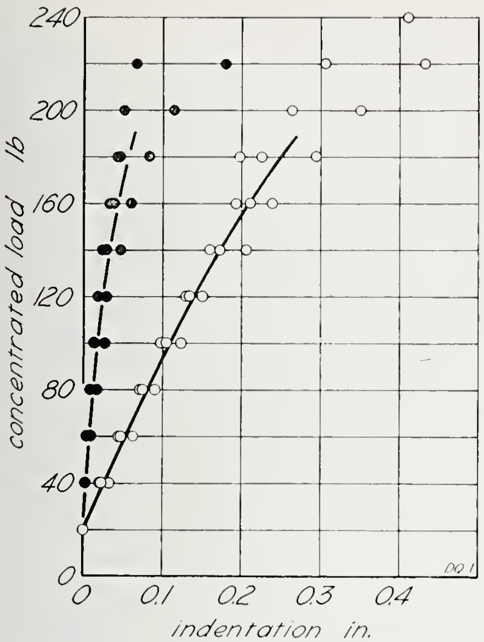

Figure 12.—*Concentrated load on wall DQ, load applied to inside face.*

Load-indentation (open circles) and load-set (solid circles) results for specimens *DQ–P1, P2,* and *P3.*

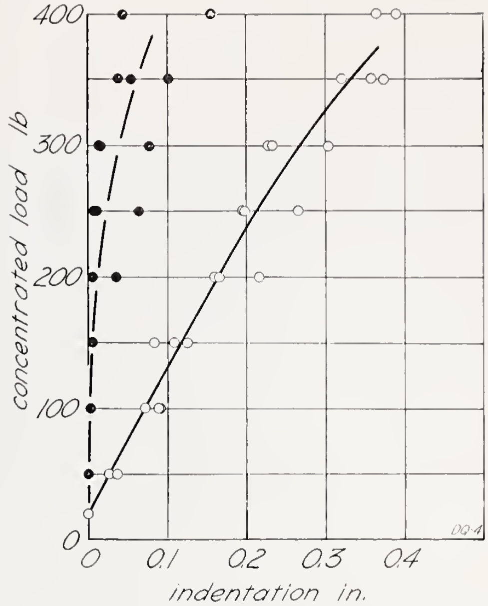

Figure 13.—*Concentrated load on wall DQ, load applied to outside face.*

Load-indentation (open circles) and load-set (solid circles) results for specimens *DQ–P4, P5,* and *P6.*

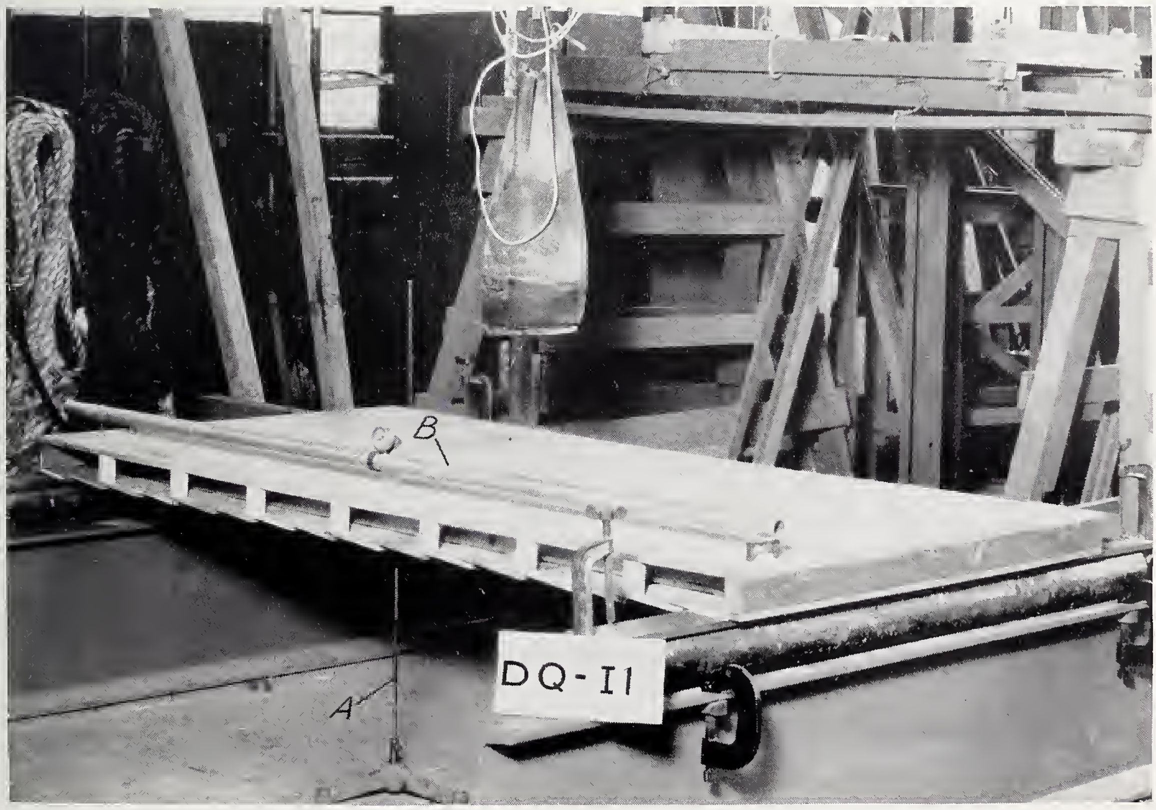

Figure 14.—*Wall specimen DQ–I1 during the impact test.*

A, deflectometer; *B,* set gage.

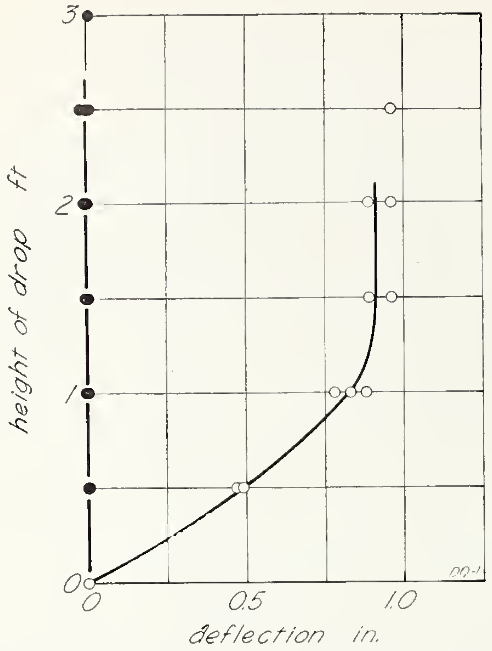

FIGURE 15.—*Impact load on wall DQ, load applied to inside face.*

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

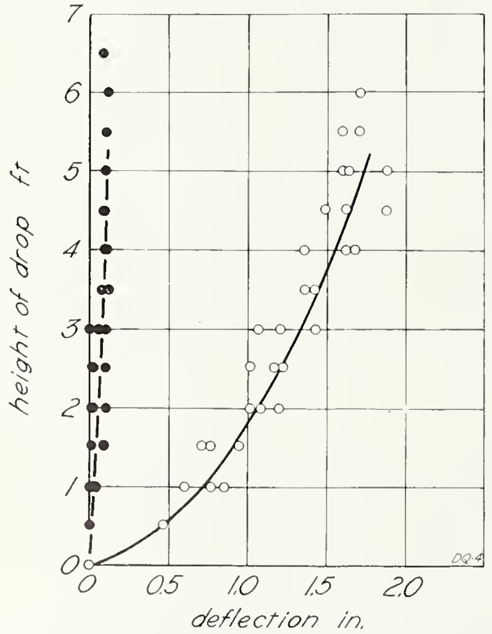

FIGURE 16.—*Impact load on wall DQ, load applied to outside face.*

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

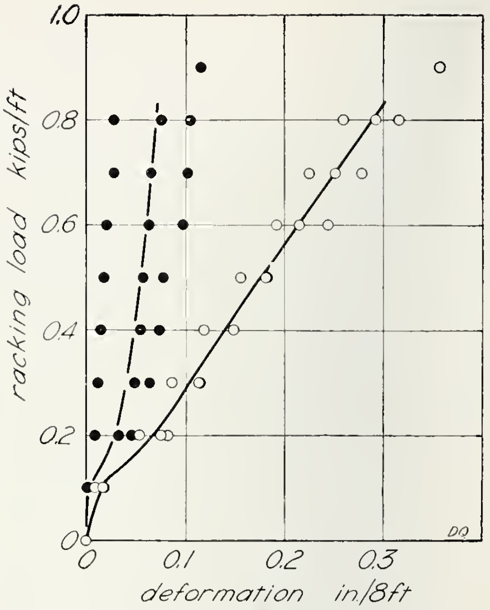

FIGURE 18.—*Racking load on wall DQ.*

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

plate at the diagonally opposite corner of the specimen.

Under the maximum load the fiberboard separated from the frame along the top and bottom of specimen *R1*, along the top of specimen *R2*, and along the bottom of specimen *R3*. Also there was some local crushing of the fiberboard of specimen *R1* at the loaded corner and at the stop.

VI. COMMENTS BY SPONSOR

The construction described in this report was developed for defense housing and specifically for 5,000 houses to be built at Portsmouth, Va. All the houses will be completed in 5 months. They are designed to be demountable; the sections are joined by bolts and lag screws. These features are not apparent in the finished building, which closely resembles a conventionally built house.

Two important factors affecting the design of this construction were availability of Homasote fiberboard and shortage of other building materials. Metal fittings have been eliminated wherever possible. Homasote was used only as interior wall and ceiling surfaces and was not used as sheathing on exterior walls, subflooring,

FIGURE 17.—*Wall specimen DQ–R1 under racking load.*

A, deformeter; *B*, dial micrometer; *C*, stop.

or roof sheathing as it was in previous constructions of this manufacturer. Typical details are shown in figure 19. Elements are fabricated in a shop near the building site, where jig tables facilitate assembly.

Floor sections are approximately 7 ft wide and 12 ft long. Girts (2 by 10 in.) and joists (2 by 6 in., 16 in. on centers), resting on ledger strips nailed to the girts, are supported on precast piers. Blanket insulation is installed between the joists, and factory-finished flooring is laid over the framing.

Wall sections are 7 ft 10 in. high and may be as long as 21 ft. The 2- by 3-in. studs are spaced 12 in. on centers in all exterior walls and load-bearing partitions and 16 in. on centers in other partitions. To these frames Homasote is fastened by glue and nails to form all interior surfaces. Building paper and wood bevel siding are applied to the exterior of all outside walls.

Ceiling sections consist of joists (2 by 4 in., 12 in. on centers) which are cross furred on the bottom with furring strips (1 by 2 in.), to

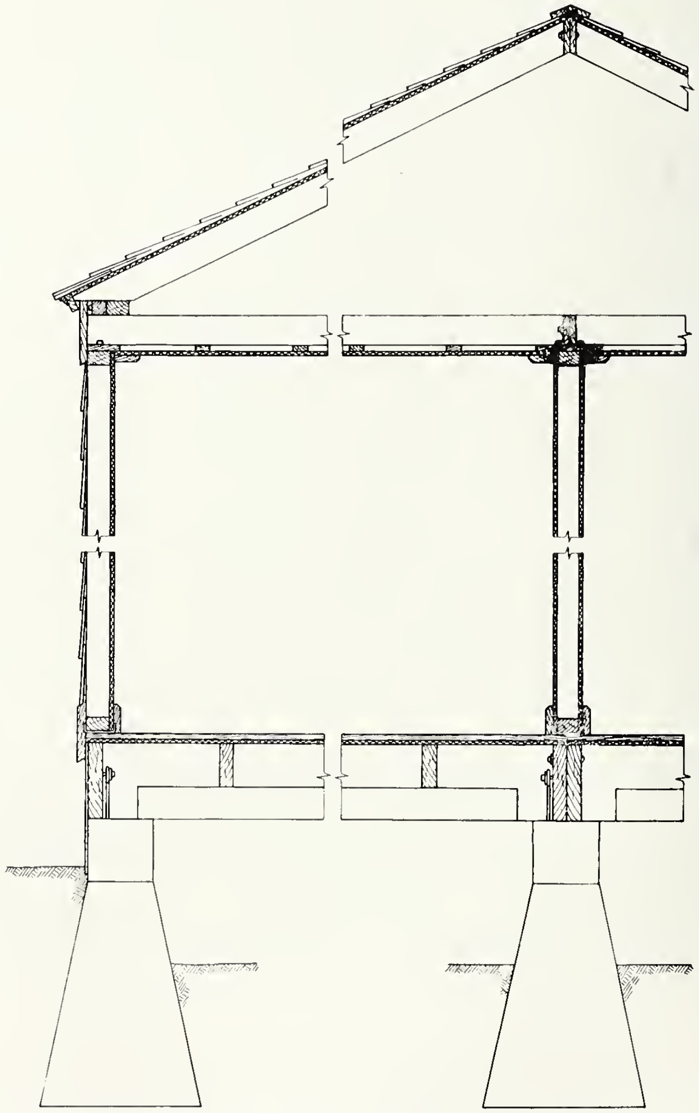

FIGURE 19.—*Typical details of "Precision-Built, Jr." (second construction) house.*

which Homasote is glued and nailed. Blanket insulation is installed between the ceiling joists directly on the furring strips.

Roof sections consist of rafters (2 by 6 in., 16 in. on centers) to which $\frac{5}{16}$-in. plywood sheathing is nailed. Asphalt shingles are applied after the house is erected.

The physical properties of the fiberboard were determined by C. G. Weber, of the Paper Section of this Bureau, under the supervision of B. W. Scribner.

The descriptions and drawings were prepared by E. J. Schell and G. W. Shaw, of the Building Practices 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 M. F. Peck, with the assistance of the following members of the professional staff: R. Goldberg, E. I. Peizer, and L. R. Sweetman.

WASHINGTON, June 9, 1942.

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BUILDING MATERIALS AND STRUCTURES REPORTS

[Continued from cover page II]