A COST COMPARISON BETWEEN RESIDENCES OF WOOD AND STEEL FRAMED CONSTRUCTION

THESIS FOR THE DEGREE OF B. S.

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THESIS

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Much study has been made on the development of the steel frame house during the last few years, and through the tireless efforts of a number of progressive designing architects, engineers and builders, together with the co-operative support of several steel manufacturers, structural steel fabricators, and the American Institute of Steel Construction, the steel frame house has become a reality. In this discussion, I will endeavor to show that the steel frame house, besides being past the experimental stage as far as practibility of construction is concerned, is also an economically sound investment from a financial standpoint. To accomplish this I am setting forth two designs- the one of customary wood frame construction, giving the detailed cost of all wood that enters into its construction, and the other- for purposes of comparison- the same residence with steel framing and reinforced concrete floors with the corresponding itemized bill of material and the approximate cost of construction.

Aside from an occasional reference to the plans and specifications of the wood frame house, I propose to consider this part of the problem completed with the presentation of the floor plans elevation drawings, bill of material and cost, and a complete set of specifications. The actual comparison with the steel frame construction will be postponed until later in the thesis.

Until about twenty years ago, the steel frame house was in its infancy and almost unheard of, but after this relatively long period of experiment and development, the use of steel in

small residence construction has reached a point of practibility and public acceptance that warrants the attention of progressive builders. There are now enough steel frame houses that have been occupied from one-half to three years or more to indicate the unusual characteristics which such construction offers to a typical residence.

Before describing the particular type of construction that will be used in this steel house, it is important to answer a number of questions that immediately arise in the mind of any prospective builder, be he a suburban developer or an ordinary investment builder. One of these questions is "how do insurance companies look upon steel frame houses as sound investment risks?" One of the great insurance companies which lends millions of dollars has accepted annually several applications for loans upon steel frame dwellings. Also it is interesting to note that a construction engineer assigned to the survey as to whether they furnished a ready market in case of forced sale, and whether they demanded a legimate premium in comparison with that paid for the normal loan, and whether the construction was sound, reported the construction sound, recommended an appraisal 10% higher than for light wooden structures, and because of the approximate 10% increase in cost of steel framing, the company recognized the premium paid as a sound investment.

The next question that arises is in connection with the insurance rating. Inthe case of a steel house in Indianapolis, the prevailing rate for frame construction in the suburb in which it was located was 55¢ per $1000 for three years.

The rate granted for the fireproof steel construction was 45¢ for the same period. In Columbus, Ohio, the steel frame house received a rating of 12¢ per $100 annually over against the wood frame rate of 16¢ per $100 per year. In still another case the New York State Board of Fire Underwriters indicated that where fire alarm boxes and hydrants are installed in the vicinity of a steel frame house, the regular rate of 50¢ per $100 would become 30¢ per $100.

Obviously, insurance companies recognize the steel home as being fireproof and when we stop to consider the percentage of our 24,000,000 homes that are destroyed by fire each year, namely about 2% or 480,000 homes, the consideration of fireproofness is a worth while item for prospective builders to remember.

Next comes the question as to the advantages of steel construction to the tenant. This is perhaps the most important consideration since in it is reflected the attitude of future buyers and tenants.

Inthe first place, residers in steel frame houses claim for them "an utter lack of noise and vibration in the entire structure during high winds, improvement of accoustical properties over ordinary wood construction and the fact that transmission of sound through walls and partitions is minimized, together with the fact that heat transmission through walls seems less than is the case with ordinary siding construction or even brick veneer or stucco on wood." there is stressed also the freedom from plaster cracks, rigidity of interior construction, adaptability to all forms of architecture both in outside design and also in the layout and furnishing of rooms.

With these few paragraphs it becomes obvious that the

quality of steel frame houses is much higher than the quality of an equivalent wood construction.

Specifications of work to be done and materials to be furnished in the erection and completion of a wood frame house for Mr.----------at ---------- according to plans and these specifications prepared by:

Howard J. Berkel.
Candidate for a degree of Bachelor of Science.

BONDS.

Bidders shall include in the amount of their bids the cost of bonds for the faithful performance of the work and payment of all bills for labor and materials. One bond shall be for (30%) thirty percent of the amount of the contract for the faithful performance of the contract and another bond for the same amount for the guarantee of payment of all bills for labor and material required to complete the contract. Each bond shall also & cover guarantee for a period of two years from final date of final certificate against defects of material, workmanship or payment of bills. Bonds to be approved by the owner of the house.

INSURANCE:

The owner of this house will obtain and pay for Fire & Wind Insurance on this building to be assigned to the owner and contractor as their interest may appear.

LOCATION:

The site of this building is located at_____ and must be inspected by the contractor before submitting his bid.

SCOPE OF WORK:

These specifications cover the general construction work for the erection and completion of this house, complete

in all respects as expressed or implied in these specifiaations.

The contractor shall provide all sundry work and materials necessary for the erecti n and completion of this building as called for or implied in these specifications and accompanying prints.

Grades will be furnished by the owner as they are required by the contractor.

The contractor will assist and work with the owner or other contractors such as ; Heating contractor, Electrical contractor, Plumbing contractor as may be required to carry out the work and leave the building complete.

At such times as may be deemed necessary by the owner , the contractor shall clear away all debris boyh in building and on grounds and leave the building clean and to the entire satisfaction of the owner.

PROPOSALS:

Sealed proposals will be received at the office of the owner, Mr.---------- up to and including ----------,1931 at two (2) o'clock P.M. Central Standard Time, for the furnishing of all materials and performing all labor required for the erection and completion of a wood frame house for Mr,---------- at ----------. Bids will be received on the general construction work according to the plans and specifications prepared by Howard J. Berkel.

Plans and specifications may be seen at the office of the Architects_____and may be obtained for the deposit of $___ for each set of plans taken which deposit will be returned upon receipt by the architects of the plans and spec-

ifications in good condition and on the date agreed upon du the date when the same are received.

All bids shall be made in schedule form on blanks which shall be securable at the office of the architects.

Each proposal must be accompanied by a certified check of five percent(%5,) of the amount of the proposal, made payable to the owner, Mr._____ ,which shall be forfeited to the owner if the bidder whose proposal has been accepted, fails to enter into the contract or to furnish the required bonds within seven (7) days after the award of the contract.

Bids must be sealed and marked "Bids for the Good Frame House of Mr._____."

The owner retains the right to reject any and all bids.

The unsuccessful bidders will be returned their checks upon the final award of the contract executed and approved.

Bids must be according to the proposal sheet, otherwise they will receive no consideration.

CONDITIONS.

APPLICATION OF CONDITIONS:

These conditions shall apply to and govern all phases of the work with equal force whether the work is done under one entirecontract or under several contracts; both for general construction and for all other contracts applicable to the same.

SUBSTITUTION OF MATERIAL:

In figuring this work if the contractor wishes to substitute any material or manufacture other than that specially mentioned in these specifications as priveledged by the word "equal" he must state same in his proposal; otherwise the material or manufacture originally demanded in the construc-

tion will be demanded and no substitute allowed. In case any such substitution is made it must first be approved by the architect before purchase; and all workmanship and material shall conform to and be governed by the original materials requirements in the specifications written for it.

PROTECTION OF SHADE TREES AND SIDEWALKS:

Contractor must take all precautions to prevent injury to trees and sidewalks. All damage done during construction of the building shall be made good at the expence of the contractor.

SCHEDULES FOR BIDS AND ESTIMATES:

Contractors bidding upon any work shall file with the architects an itemized schedule of their propisition uponrequest from the architects either before or after the contracts are let.

The contractor to whom the contract is awarded must file with the architect a complete schedule of all quantities of materials and labor and the cost of each, before an estimate will be allowed.

The contractor will be responsible for the accuracy of the schedule but it shall not be considered a part of the contract . It shall be used as a basis for the settlement with the contractor and shall govern the cost of additions or omissions as provided for .

CO-OPERATION OF DRAWINGS AND SPECIFICATIONS:

The specifications and accompanying drawings are intended to describe and provide for a finished piece of work. They are intended to be co-operative and what is called for in either shall be as binding as if called for in both. The

contractor must understand that the work herein described shall be complete in every detail, notwithstanding every item involved is not particularly mentioned, and the contractor will be held to provide all materials and labor necessary for the completion of the work intendedto be described in its entirety; and may not avail himself of any manifestly unintentional omission or error. No oral admission or condonation of inadvertant neglect on the part of the architect will be accepted as an excuse for poor work or omission of any kind in either work or materials.

DETAILED INSTRUCTIONS:

Should it appear that the work herein intended to be done, or any part of the matters relative thereto, are not sufficiently clear as explained on the drawings or as shown on the drawings, the contractor shall apply to the architect for further drawings and explanations as shall be necessary, and the architect shall be consulted in the event of any doubt or misunderstanding arising respecting the true meaning of the drawing and specifications.

ERRORS AND INCONSISTENCIES:

Shall any error or inconsistency appear or occur in drawings or specifications, the contractor before proceding with the work, shall make mention of the same to the architects for the proper adjustment; and in no case shall he proceed with the work in uncertainty. For all delays and extra materials occasioned by such mistakes resulting from this, the contractor shall be held responsible for not having them explained or corrected.

MEASUREMENTS:

The general contractor and all sub- contractors employ-

ed upon this building shall verify all measurements at the building for dimensions, and arrangement and construction of their respective works. The approval of shop drawings by the architect does not release the contractor or sub-contractor from responsibility for correctness of measurements, dimensions, figures, etc.

The contractor must keep himself familiar with the drawings and specifications concerning all parts of the work and must compare the work done with the drawings. He shall make no alterations in plans, details, or specifications; neither shall he interpret anything not fully understood but must refer all such matters to the architect.

SUB-LETTING THE WORK:

The sub-letting of all or any part of the work shall not be assigned without the written consent of the architect.

OWNERSHIP OF PLANS AND SPECIFICATIONS:

The plans and specifications are instruments of service only and shall remain the property of the architect; and shall not be copied nor used for any other work than herein described.

GRADES, LINES, ETC.

The owner shall establish the lot lines, shall determine the grades and shall determine the position of this building on the lot and the contractor shall carry out his work accordingly.

LIABILITY INSURANCE:

Each contractor and sub- contractor shall provide, maintain and pay for all accident and liability insurance for all workmen employed by him in connection with the work on this

building during the entire progress of the work and shall pro-

protect the owner from all damages which may arise through any accident which may happen to any person or workman about the premises or passing the same and which results from either contact or extra work under his charge. All of said Liability Insurance shall be maintained strictly in accordance with the laws relating to same in the State of M-------, and the contractor must on request of the owners, show satisfactory proof of the maintenance of such insurance.

ACCESS TO BUILDING:

The owner shall have access to the building at any time during the construction of same.

PERSONAL ATTENTION:

The contractor shall give this work his personal attention and supervision and shall place a thoroughly competent foreman in charge at all times at the site.

GUARDS:

The contractor shall provide safety lights at night to protect the public from danger and shall provide all other guards both day and night as shall seem necessary.

DISCHARGE OR RELEASE OF INCOMPETENT WORKMEN:

Any careless or incompetent workman must be discharged and removed by the contractor and when directed to do so by the architect.

POWERS OF OWNERS TO FURNISH MATERIALS OR TO COMPLETE WORK:

Should the contractor become insolvent or at any time refuse or neglect to provide a sufficiency of properly skilled workmen or the materials of the proper quality, or failing in ant respect to prosecute the work with promptness or dil-

igence or failing in the performance of any of the agreements herein contained ;such as refusal, neglect or failure being certified to by the architecture, the owner shall have the right afterthree days written notice to the contractor to provide such material and labor and to deduct the cost thereof from any money then due or thereafter due to the contractor under this contract. If the architect shall certify that such refusal , neglect or failure is sufficient grounds for such actions, the owner shall also be at liberty after five days serve written notice to the contractor to terminate the employment of the con- from the said work and to enter upon the premises and take possession for the purpose of completing the work comprehended under this contract, of all materials, tools and appliances thereon and to employ other persons or person to finish the work,and provide materials therefor; and in case of the discontinuance of the employment of the contractor he shall not be entitled to receive any further payment under this contract until the said work is wholly finished, at which time, if remaining unpaid bal- of the amount to be paid under this contract shall exceed theexpence incurred by the owner in finishing the work, such expence forming an excess shall be paid by the owner to the contractor, but if the expence shall exceed the unpaid balance, the contractor shall pay the difference to the owner. All the above must be audited and certified to by the architect whose certificate shall be conclusive and binding upon the parties.

TEMPORARY HEAT:

Contractor shall furnish and provide all materials for temporary heat during the execution of the work, maintaining a temperature of 40°F. both day and night to protect from damage from

damages from frost. If the regular heating plant can be used the general contractor must make arrangements with the heating contractor for the use of the same and must deliver the same back to the contractor in good condition. If the general contractor fails to provide fuel, etc.,necessary for the purpose, the owner shall be at liberty to provide same and charge same to the general contractor.

CLEARING AWAY DEBRIS:

Each contractor shall clear away from time to time debris resulting from his work and at completion shall clear away all debris and unused material and appliances due to his work and leave the building broom clean and in perfect condition at completion.

EXCAVATION AND FILLING:

Contractor shall excavate for the basement and place the dirt as directed by the architect. The excavation shall be larger on all sides than required for the footings and walls so that the walls may be properly coated and waterproofed up to the ground line. He shall provide sand filling on inside of building as required to bring to proper height to receive concrete grout for basement floor. this filling shall be properly puddled and tamped. All surplus earth shall be carried away by the contractor. All work must be left to the entire satisfaction of the architect at completion.

DRAINS:

Provide land tile drains on the outside of the building on all sides. the high points shall be in the back, sloping uniformly to the point the sewer leaves the ground. Tile shall be four(4(inch, use 90^{o} elbow around corners at approximately the elevation of the footings. Directions will be furnished by the

architect. The contractor shall obtain and pay for all permits.

Drains shall have the joints covered with tar paper and filled around with course gravel or broken stone for approximately twelve (12) inches above the tile, and must be inspected before being covered.

CEMENT:

Cement shall conform to requirements of "Specifications & Tests for Portland Cement" obtainable at United States Department of Agriculture.

WATER:

Water shall be free from alkali or organic matter and shall be clean, and fresh.

LIME:

All lime used in this building shall be thoroughly hydrated .

SAND AND GRAVEL:

Sand and gravel used in this building shall be satisfactory to the architect and shall be submitted to him for his approval. Special permission must be obtained from the architect to use "bank-run" gravel.

FOOTINGS:

All footings shall be at least eight (8) inches thick and extend one (1) foot each side of the wall. Concrete shall be seven gallons water to one sack of cement.(7:1).

Note.

Up to this point in the specification writing, there have been no differences between the requirements of each house wood or steel. From now on reference must be made to each separate structure and this will be done when necessary.

BASEMENT FLOOR:

The basement floor shall be six (6) inches thick placed on the sand previously tamped, and shall have a ratio of seven (7(gallons of water to one (1) sack of cement, slump not less than four or more than six (6) inches. Finish coat shall be of one and one-half inch thickness and shall be of mix: one (1) part of cement to three (3) parts sand , slump not more than three (3) inches. Cement shall be power mixed and mixed for three (3) minutes. Cement shall be kept wet for one week after initial set. The finished floor shall be trouled smooth and left in a workmanlike manner.

BASEMENT WALLS:

Steel; In the steel house, the basement walls shall be of monolithic concrete, compressive strength of at least 2000 #. with anchor bolts placed in the concrete at six (6) foot intervals embedded one (1) foot in the concrete and protruding for three inches or sufficient for fastening the channels which form the sill.

Wood; In the wooden structure, the basement walls shall be of precast cement blocks of 2000# per square inch compressive strength, or an approved equal. Anchor bolts of usual type shall be cemented in to the top block to receive the 2x6 which forms the sill.

DRAINS UNDER BASEMENT WALLS:

Provision shall be made for the placing or setting of four inch (4) inch sewer pipe under the floor before the concrete is poured.

EXTERIOR BRICK WORK:

Steel; The exterior brick shall be chosen by the owner. The mason shall see that all sills are properly leveled and that

all frames plumb before bricking them in. All openings shall be built of exact sizes to receive windows and doors.

The exterior brick work shall be laid one inch from the sheeting to form a dead air space.

CHIMNEY:

Footings shall be built one foot larger than the base of the chimney and reinforced with one-quarter inch steel bars @ 6" center to center each way. Brick shall be of common, hard-burnt, merchantable brick up to the roof and of the same kind as chosen for the exterior brick from there on.

FIRST AND SECOND FLOORS:

Wood:

Construction of first and second floors in the wood house shall be of two by six joists and two by four studs, with hard wood flooring in all rooms except the bathroom.

Steel:

Both the first and second floors shall be of 5" Carnegie beams (10#) , on which shall be fastened Steeltex floor lath by manner as shown in detail given in connection with this. A poured concrete floor 2½" thick is laid on the lath in all rooms except the bathroom , both on first and second floors in which case the detail is as shown in figure 10b.

ROOF:

The roof shall be of two by six rafters in the wood structure on which is laid the sheeting and finally the asphalt shingles.

In the steel house the roof shall be formed by 3" channels spaced at four foot intervals. On the backs of these channels shall be fastened a nailing strip as shown in figure 10r. On the nailer strip shall be laid a layer of approximately one inch sheeting on which shall be laid the tile roofing. Details for the connection of rafters at peak and also at sill are shown in figure 10s.

The roof board shall be of the same tile as the roof and shall carry the same guarantee as the roof, namely twenty (20) years.

SHEETING:

All sheeting on exterior walls shall be of Steeltex for brick veneer furnished by National Steel Fabric Company , Pittsburgh, Pa. It shall be attached to the studs by means of the attachmentstay which is furnished especially for this construction by the same company.See detail 10t.

Partitions;

The partitions on the interior wall construction shall be madel of 1½" steel channel on which is electrically welded at 5" intervals a 14 guage galvanized Attachment prong. This shall be furnished at the National Steel Fabric Co, also. Ribbed Steeltex lath shall be fastened to these attachment prongs and plaster applied to the lath. All corners shall be reinforced with National Reinforcing for corners and joints to be applied in accordance with the manufacturers directions. Also furnished by the same company that furnished the lath and the channels.

PLASTER:

The plaster shall be of Kelly Island or an approved equal. Three (3) coats shall be applied and the third coat shall be given a rough finish. In the bathroom the walls shall be of tile construction for the first four feet from the floor and from there on the same finish as specified for the other walls.

All work shall be straight, plumb, and true.

CEILINGS:

Ceiling construction shall be of Steeltex V- shaped attachment bar, to which is clipped the Steeltex lath for ceilings as shown in the detail covering this construction. See figure 10c.

TILE:

The tile for the bathroom walls and floors shall be of the quality supplied by the United States Quarry Tile Co., or an approved equal.

STAIRWAYS:

Stairways shall be of steel constraction such as supplied by the Haven Bush Company, Grand Rapidsn Mich. The treads shall be covere. with hard wood to match the floors.

WINDOWS:

Windows shall be steel casement furnished by the Truscon Co. All frames shall be laid square and plumb and shall be properly insulated to keep out snow, wind and rain. The windows shall be equipped with the automatic swing screens of Truscon make.

FINISHING WOODWORK:

All wood work requiring finish shall be finished with three coats of the best quality varnish obtainable, the first two sanded smooth and the third left clear and smooth. All finish shall be workmanlike manner and shall be left in a satisfactory condition.

The kitchen woodwork shall be finished in gray and white enamel, two coats on top of properly filled wood. Wood work in the bathroom shall be of white enamel.

CUPBOARDS:

Cupboards shall be made of wood and the contractor shall allow approximately fifty (50) dollars for their construction.

All items not appearing in these specifications will be cared for in details furnished in connection with the thesis.

NOTE:

In these specifications, which have been compiled for the chief purpose of illustrating the differences that existed between the two residences-of wood frame and of steel construction, no reference has been made to details which are obviously alike in both houses. Examples of such omissions are: Plumbing specifications, heating recommendations, electrical specifications,

existing differences have been referred to when they seemed important.

COMPUTATIONS:

Roof;

Wind load----	4 x 30 =	120.0#
Steel--------	1 x 17.5 =	17.5#
Sheeting-----	4 x 4 =	16.0#
Snow load----	4 x 20 =	80.0#
Tile---------	4 x 15 =	60.0#
Nailer block-	=	2.5
		295.75#

These are the loads per foot of rafter at a spacing of four (4) feet between rafters.

Values for loads taken from "Theory of Structures" by Spofford.

Shear;

200 x 9.5 = 2850# Reaction.//

Bending Moment:

For 9.5' length- 1/8 x 9.5 x 9.5 x 12 x 295.75 = 40,000 #/sq. inch.

For 19' length- 1/8 x 19 x 19 x 12 x 295.75 = 160,000#/ sq. inch.

$\frac{M}{S} = \frac{40,000}{16000} = 2.5"$ $\frac{M}{S} = \frac{160,000}{16,000} = 10"$

Use last value and from Carnegie Pocket Companion for a Modulus of 10" use an 8" channel- 15.25#. Carnegie.

Second Floor:

Live load--------	40#/ sq. ft.
Concrete 2½"-----	8#/ sq.ft.
Wood floor-------	6 #/ sq. ft.
Steeltex lath----	1#/ sq. ft.
Steel Joists-----	20#/ sq. ft.

Try spacing of 36" between joists--

87# x 3' = 261 #

Bending moment for 11' length -

$\frac{261 \times 11 \times 11 \times 12}{8} = 47,500$ #

$\frac{M}{S} = \frac{47,500}{16,000} = 2,95"$

Bending moment for 13' length--

$$\frac{251 \times 13 \times 13 \times 12}{8} = 36,250 \text{ "}\#$$

$$\frac{I}{5} = \frac{36,250}{10,000} = 4.15"$$

Therefore use Carnegie 5"- 10 # beam for joists spaced 5'

Use a #4 two-- 1½" x 1½" x 5/16" angles on each side of ridge to support the rafter channels.

Weight of partitions:

Steeltex for partitions-----	3 / sq. ft.
Plaster----------	20 / sq. ft.
	23 / sq. ft.

Total weight of partition for an 8' ceiling = 8 x 23 = 184 / sq. ft.

Use Pedlar steel studs formed by two angles , hot-rolled, copper-bearing steel fabricated to length with welded clips to hold the angles in place. The studs herein described will be used on exterior walls only ,this in order for the application of wind bracing to be possible. These studs are 5" from face to face, and are perforated with 7/16" holes on 2" centers. See detail 10a. The sills are formed by welding two channels back to back to which are welded the studs.

First floor:

Live load-------	80 / sq.ft/
Plaster---	4 / sq. ft.
Concrete-----2½"-	8 / sq. ft/
Steel -----------	15 / sq. ft.
	89

Total = 89 x 3' = 267/

Bending moment for 11' 6" span=

$$\frac{267 \times 11'6" \times 11' 6" \times 12}{8} = 54,000 \text{ "}\#$$

$$\frac{I}{5} = 5.3"$$

Bending moment for 18' span =

$$\frac{267 \times 13 \times 14 \times 12}{8} = 67,700 \text{ "}\#$$

S= 4.6"

Therefore use 5" - 10 Carnegie beam.

For the 6- arch between Dining room and Living room use same.

BILL OF MATERIAL AND COST LIST OF LUMBER NEEDED IN ERECTION OF GOOD RESIDENCE.

80 pcs.	2 x 8- 12	#2 yell. pine.	44.63
20 pcs.	2 x 8- 14	#2 " "	
200 lin.'	2 x 2	Fir	2.55
One keg	8d Coated nails		4.75
One keg	16d " "		4.30
1100 ft.	1 x 6	#3 Y.P. sheeting	25.30
150 pcs.	2 x 4- 8	#2 Y.P.	
126 "	2 x 4- 16	"	57.89
20 "	2 x 6- 12	#3 Y.P.	6.48
2000 ft.	1 x 8	#3 Y.P. sheeting	50.00
1500 "	1 x 6	#3 " "	34.50
20 pcs.	2 x 8- 12	#2 Y.P.	6.48
100 lin.'	1 x 4	#2 Y.P.	1.32
60 pcs.	2 x 4 -4	#2 Y.P.	
30 pcs.	2 x 4 - 6	#2 Y.P.	35.10
35 "	2 x 4 -10	#2 Y.P.	
8 "	2 x 8 -16	Cal. Fir	
6 "	2 x 8 -10	" "	25.10
200 lin.'	1 x 8	#2 Y.P.	
250 "	1 x 4	"	16.20
600 ft.	1 x 4	#1 Fir Clg.	36.00
150 lin.'	1 x 6	#2 W.P.	5.63
324 "		#2 Crown Molding	8.10
350 "		#2 Board Molding	8.75
2 Bdls.		#2 Wood Shingles	2.50
5 Rolls		1-Ply Roofing	6.25
30#	8d Coated nails		1.80
20#	6d " "		1.20
15 Sq.	12½ Fawny Blind		101.25
5 pcs.	2x 4- 10	#2 Y.P.	.89
20 pcs	2 x 4-8'	#2 Y.P.	2.89
4 "	1 x 4-12	#1 Fir Clg.	.96
5 "	1 x 10- 12	#3 Y.P.	1.85
10 "	10' Green Strip Shingles		.60
310 lin.'	4½ Plowed Jambs		21.70
82 "	Plowed Sills		16.40
1 piece	2 x 8- 12	#3 Y.P.	1.85
300 lin. '	2 x 8	#2 W.P.	10.00
5 pcs.	1 x 6-14	#2 W.P.	2.65
280 lin.'	Blind Stops		5.60
275 "	6/8 Check Stops		2.75
100 "	1/8 Drip Cap		12.75
100 "	1 x 4	#2 W.P.	3.75
100 "	1 x 12	#2 Y.P.	45.00
10 pcs.	2 x 4-8	#2 Y.P.	1.43
8 "	Side Jambs with 5/6 pulleys & pockets for two light windows		
8 "	Side Jambs with 1/4 pulleys and pockets for two light windows		
14 "	Side Jambs with 3/8 pulleys and pockets for two light windows		9.52
Labor on above			7.50
5 doz.	sash pulleys		3.75
1 piece	2 x 8 -14 sill	#1 Y.P. Bevelled	.95
Bevelling on above			.45

3200 ft. Rock Lath	72.00
50 # Blued Rock Lath Nails	4.00
16 Brackets	5.00
161 ft. 5/8 x 4-12c Cl Y.P. ceiling	10.66
150 ft. 1 x 4- Cl. Fir Flooring	12.75
60 lin.' 1 x 8----------#2 W.P.	3.00
1 piece 1 x 4 -12---------#1 Fir Clg.	.24
2 pcs. 1 x 12 -12--------#2 W.P.	1.93
5 pcs. 2 x 4 -12---------#2 Fir	1.43
22 ft. 3" Drip cap	1.32
20# 8d Coated nails	1.20
10# 16d Coated nails	.50
1 piece 2 x 8- 14 -------- #2w.p.	.40
150 ft. 7/8 cove mldg.	1.25
1 pail Asbestos Cement	.75
1 piece 1 x 12-14 ------- #2 W.P.	1.12
1 piece 2 x 8 -14 -------#2 W.P.	1.71
1 roll 1-ply roofing	1.25
540 ft. Celotex Lath	27.00
One -M-- 48" lath	7.50
One -M- 32" lath	4.00
15# Blued lath nails	1.20
7800 ft. ½ x 8 C. Cedar Siding	117.00
1 piece 2 x 17- 2/0 -------#2 W.P.	.36
8 pcs. 1 x 4-8----------#2 Y.P.	.84
1 piece 1 x 8-12----------#2 W.P.	)
1 " 1 x 6 -12----------#2 W.P.	8.25)
1 " 2 x 4 -12----------#2 Y.P.	.72
25# 6d Coated nails	1.50
1 Wind 20 x 16 -"2lt. top cut three hts.	2.15
2 Winds 18 x 16 - "" " " " "	4.20
8 " 20 x 16 Bottom cut 20 x 14, top three hts.--	18.80
3 Sash each opening 2½ x 30 cut three hts.	8.55
1 " " " 24 x 24 " " "	2.25
2 " " " 14 x 32 " " "	4.00
1 " " " 44 x 38 " par bar	3.10
1 " " " 44 x 16 2" bound past cut 6 lts.--	3.20
2 " " " 22 x 16 "" " " " 4 " --	2.90
4 Winds 22 x 26 2 lt. cut top par bar	11.00
4 " 20 x 20 " " " " "	9.40
52 lin ft. 1¼ lattice	.78
975 ft. 1 3/16 x 2¼ third grade Maple flooring	63.38
1 door 2/8 x 6/8 Fernwood 1 3/8 W.P.	10.35
1 " 2/8 x 6/8 Pippin 1 3/8 W.P.	5.00
1 " 2/6 x 6/8 " " "	5.00
1 " 2/6 x 6/8 J 5 panels	4.00
10 pcs. 1 x 5¼ - 16 cl. Y.P.	9.20
270 ft. 2¼ 2nd grade Oak flooring	25.65
100 " 1 x 12 #2 Y.P.	4.50
100 lin.'1 x 10 "	3.74
300 " 1 x 4 "	[illegible])
300 " 1 x 6 #	10.00)
200 " 1 x 2 #1 Y.P.	4.00
260 ½ x 1 5/8 BN stops	5.85
300 ½ x 13/8 BN stops	5.25

625'BB Molding ---------- 2.25
200'BB Casing ----------8.00
80' 3½ stool ---------- 5.60
170' Shoe Molding ---------- 1.70
120' 2¼ 3rd grade Maple flooring ---------- 7.80
3 Oak Thresholds---------- 1,20
200 lin. ft. 1 x 4 #2 Y.P.----------2.68
10 1-panel Lockwood doors ----------50.00
1 piece 3' crown molding 10'---------- .38
50 lin. ft. 4 x 4½ C. Casg. CL. Y.P.---------- 2.50
40 " " 3½" apron " ---------- 1.60
100 " " " BB Casg. ---------- 4.00
170 " " 5½ Base ----------10.20
2 pairs 9½- 14 Base---------- 3.78
1 " Oak nosing 1 1/8 x 3½ x 4/0
1 " Maple " 1 1/8 x 3½ x 5/0----------1.80
60 lin. ft. 1 x 8 CL Y.P. C&S----------4.60
1 Pl. Newel Post ---------- 6.00
1 Built-In Ironer ---------- 7.80
5 Oak Treads 1 1/8 x 11 x 46" ----------11.25
1 Oak " 1 1/8 x 11 x 52" ---------- 2.50
6 Maple Treads 1 1/8 x 10 x 36" ----------10.50
5'Built up Hand rails---------- 2.00
250lin. ft. shoe molding ---------- 2.50
2 pieces 2 x 4 -12 #2 Y.P.---------- .43
2 Doors 2/4 x 6/8-5 panels #1 ---------- 8.00
3 pieces 1 x 12 -13 #2 Y.P.---------- 1.62
3 0 ft. 2½" chair rail ---------- .84
2 cupboard doors 16½ x 28---------- 3.50
2 " " 13½ x 38 ---------- 3.50
2 " " 20 x 26 ---------- 3.50
2 " " 21 x 27 ---------- 4.00
1 " door 15 x 54 ---------- 3.00
1 " " 15 x 21 ----------1.25
8 Drawers ----------27.00
8 Turned Spindles ---------- 5.40
1 piece 1 1/8 x 1 1/8 x6 Oak ---------- .42
2 " 2 x 4 -12 #2 Fir ---------- .43
30 lin. ft. 1 x 8 #1 Y.P.---------- 1.50
80 " " 1 x 4 #2 W.P. ----------)
1 piece 1 x 6 -14 #2 W.P. ----------2.55)
24 lin. ft. 1 x 4½ Plowed Jambs ---------- 1.68
60 ft. 5/8 x 4 CL Y.P. clg. ---------- 3.90
24'Check Stops ---------- .24
24 Blind Stops ---------- .48
1 Oak Threshold ---------- .40
2 Combimation doors 2/8 x 6/8 ---------- 15.00

Total cost of lumber necessary to build the wood frame

)1412.64

STEEL BILL FOR STEEL RESIDENCE.

8-	8"-16.25# Channels	28' 0"	3640#	Punched to receive
10-	8"-16.25# "	18' 9"	3050#	nailer and welded
10-	8"-16.25# "	5' 9"	935#	plate.
2-	1½" x 1½" x 5/16" Angles	26' 6"	150#	No work.
2-	3"-6# Channels	36' 0"	432#	Weld back to back.
4-	3"-6# "	24' 0"	576#	Weld back to back.
2-	3"-6# "	36' 0"	432#	Weld back to back.
4-	3"-6# "	2' 0"	48#	Weld back to back.
11-	5"-10# I-Beams	12' 0"	1320#	Weld bracket for fastening to sills.
1-	5"-10# I-Beam	6' 0"	60#	Same.
2-	3"-6# Channel	36' 0"	432#	Weld back to back.
3-	5"-10# I-Beams	13' 9"	417#	Weld bracket for fastening to sills.
4-	5"-10# "	11' 6"	464#	Same.
3-	5"-10# "	15' 4"	457#	Same.
8-	3"-6# Channels	24' 0"	1152#	No work except weld back to back.
7-	5"-10# I-Beams	12' 2"	854#	Weld brackets.
7-	5"-10# "	11' 0"	770#	Same.
1-	5"-10# I-Beam	4' 0"	40#	Same.
2-	3"-6# Channels	24' 0"	288#	Weld back to back.
8-	3"-6# "	24' 0"	1152#	Same.
14-	5"-10# I-Beams	12' 0"	1680#	Weld brackets.
2-	3"-6# Channels	24' 0"	288#	Weld back to back.

NOTE: The above structural members are for roof construction, floor joists, and sills. The price as listed and including fabrication is $800.00.//

$800.00

57-	Standard Steel studs-	9' 7" @ 2.46# per foot @ 7¢/#=	$90.00
3-	" " " -	5' 2" " " " " "	2.66
4-	" " "	5' 0" " " " " "	3.45
2-	" " "	7' 6" " " " " "	2.40
4-	" " "	7' 2" " " " " "	4.93
1-	" " "	10' 6" " " " " "	1.81
10-	" " "	9' 4" " " " " "	16.10
6-	" " "	3' 0" " " " " "	3.10
4-	" " "	4' 0" " " " " "	2.76
4-	" " "	9' 0" " " " " "	6.22
15-	" " "	2' 0" " " " " "	5.17
2-	" " "	3' 6" " " " " "	1.20
1-	" " "	2' 8" " " " " "	.46
2-	" " "	8' 3" " " " " "	2.84

						Balance forwarded-	$943.10
2-	Standard	Steel	Studs-	6' 0"	@ 7#/#	@ 2.46#/ foot -	2.06
4-	"	"	"	3' 3"	"	"	2.24
22-	"	"	"	5' 6"	"	"	20.08
3-	"	"	"	2' 6"	"	"	1.29
						Total for structural members	$ 968.77

NOTE: The above structural members are what are commonly known as Standard Steel Studs being made of two $1\frac{1}{2}$x$1\frac{1}{2}$x $\frac{5"}{16}$ angles welded back to back with a space of .83" between backs of angles giving a completed member $3\frac{1}{4}$" bearing area. Small battens are used to hold the angles in their relative position and the open space between is used for the application of wind-bracing in the panels shown on the drawings, the same feature true also in the application of attachment stays shown in detail on prints.

Windows are furnished by the Detroit Steel Products Company, Manufacturers of "Fenestra" windows and screens - the types chosen for this residence being "Fencraft Casements" for veneer construction.

5-	Fenestra	Fencraft	Windows-	Type 2416-	
3-	"	"	"	- Type 2316-	
2-	"	"	"	- Type 6326-	
1-	"	"	"	-Type 6324-	
1-	"	"	"	- Type 8528-	
1-	"	"	"	- Type 6528-	Bal. 968.77
				--Total cost windows	$98.75

NOTE: The following items consist of "Steeltex" for outside walls, "Steeltex" for interior plaster, "Steeltex" for floors construction of which is fully covered in the accompanying blue prints, attachment stays, sleeper chairs, and mesh supports.

1400 square feet of Steeltex for floors	@ $4.24/100sq. ft.	$59.36
195 square yards of Steeltex for veneer	@ .36/sq. yd	70.20

Balance forwarded		$1197.08
534 square yards Steeltex for plaster	.28¢/sq.yd.	149.68
185.5 " " " for brick vencer	.36¢/sq.yd.	66.78
(including sleepers. supports)		
Grand Total for STEEL FRAME------		$ 1413.54

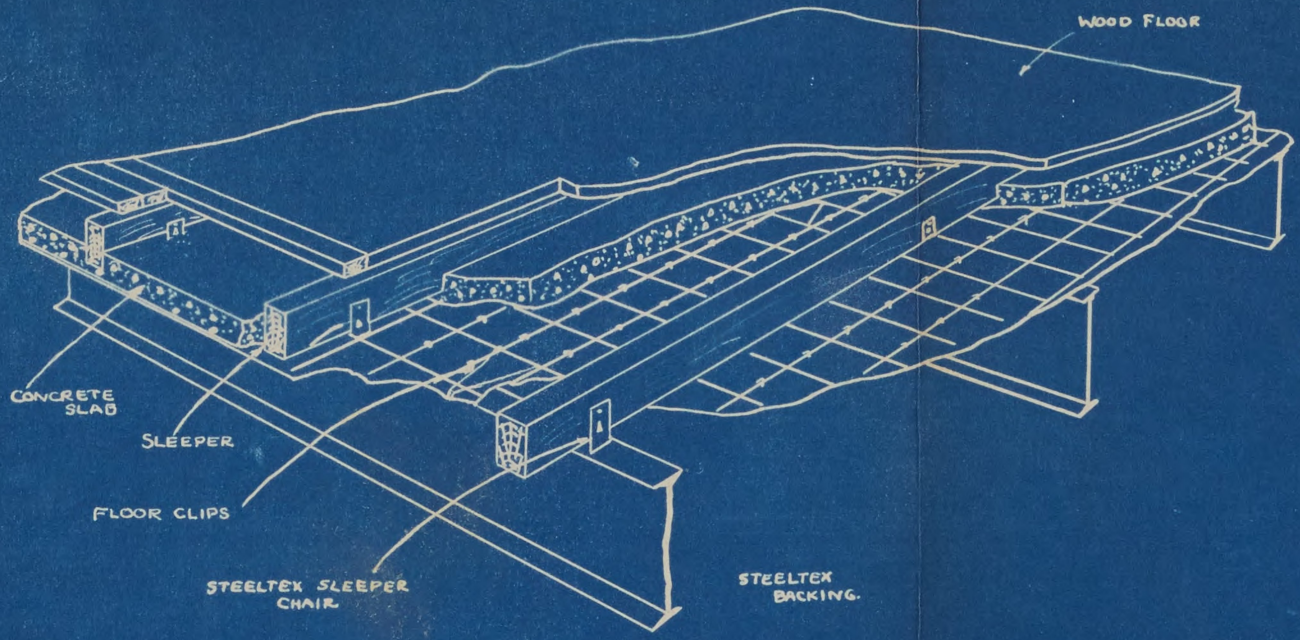
CONCLUSION:

Reference to the total cost of lumber necessary to build the wood frame house will show $1412.64 which cost,however, includes several items exclusive of the framework itself on which the comparison obviously is intended to be made. A subtraction of $ 173.89 from this total for the covering of the items referred to leaves a balance of $ 1238.75.

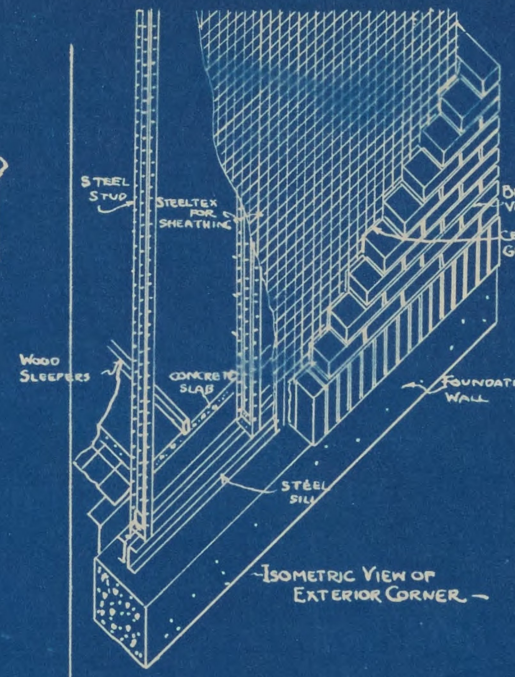
The cost of the wood frame is increased an amount of approximately $100.00 which is an estimate of the cost of erection made by an experienced contractor.

The erection of the steel frame would cost $60.00 this estimate furnished through the courtesy of the Lansing Steel Corporation, Mr. Brumm, Engineer. The steel frame is erected by welding there being 1230 lineal inches of weld needed.

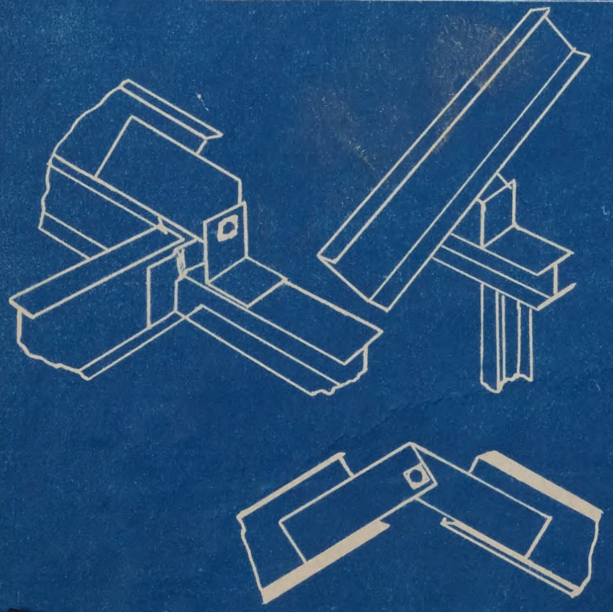
The conclusion drawn from this investigation into the relative costs of wood and steel frame construction in residences leads us to the facts that an increase in cost of only slightly over ten percent of the latter design as compared with the disadvantages and inferior construction of wood frame comstruction, will bring back to the owner and resider in the steel home,with its crack-proof, rigid, fire proof, and sound resistant walls, a return on investment scarcely comparable to the small increase in original cost.



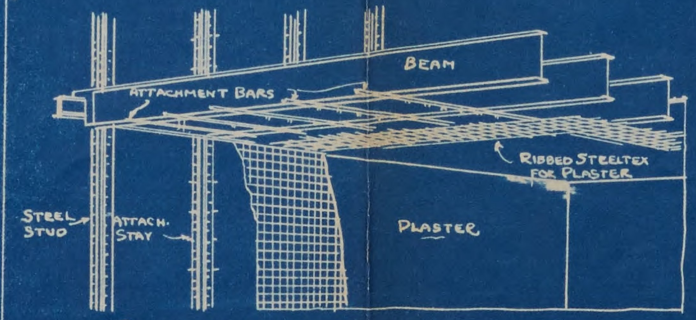
-DETAIL 10b-



-ISOMETRIC VIEW OF EXTERIOR CORNER-

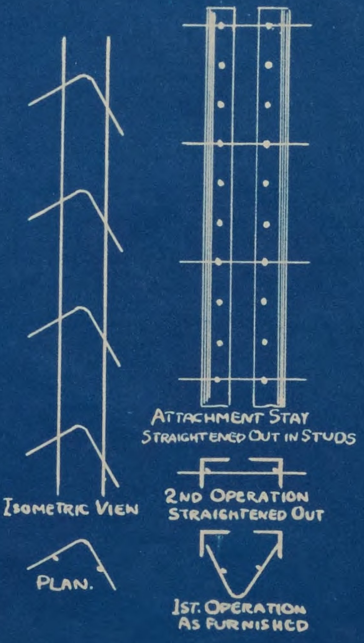


-DETAIL 10r-



-ISOMETRIC VIEW OF INTERIOR-

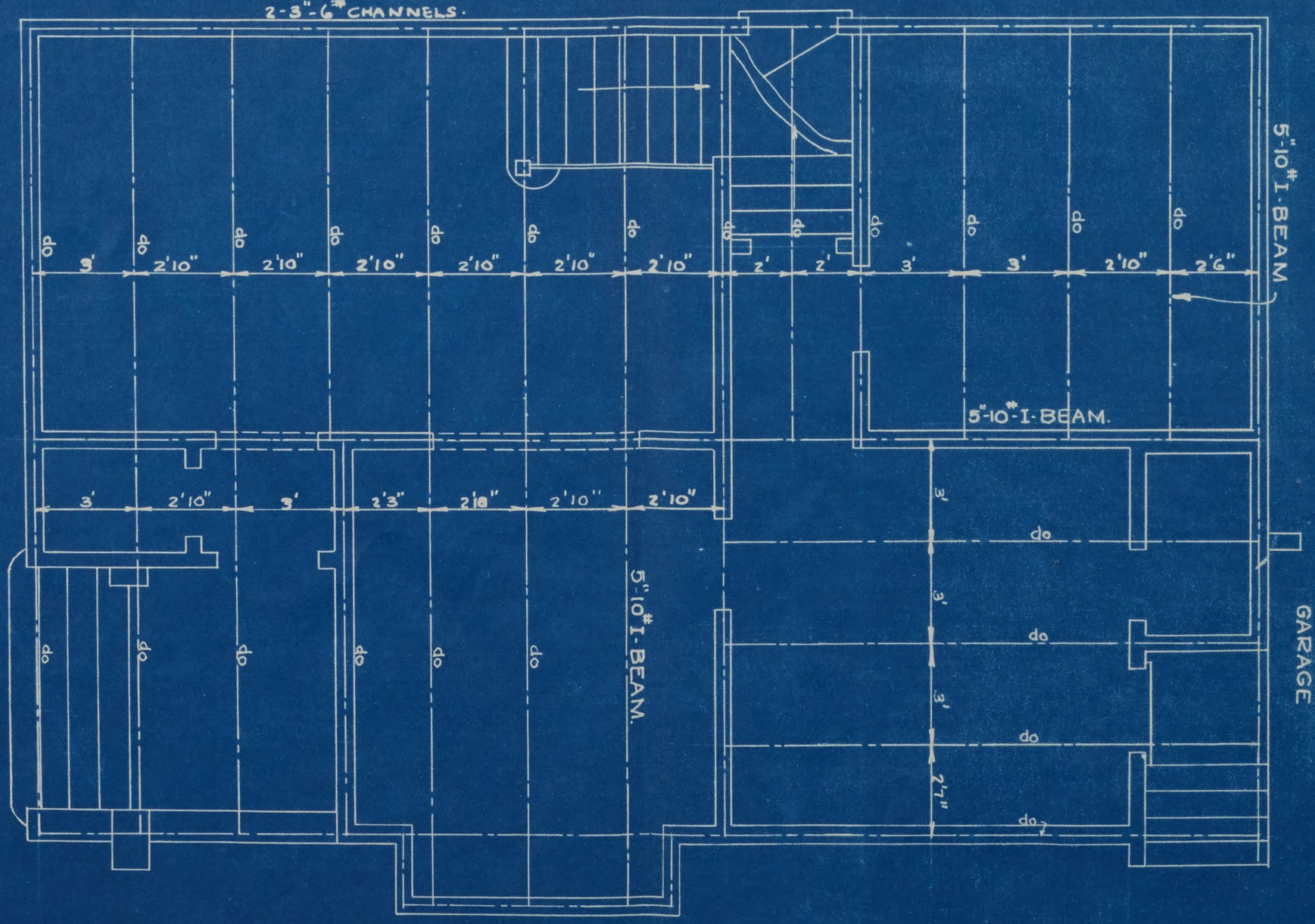
-DETAIL 10p-



-DETAIL 10t-

XI

-BERKEL-

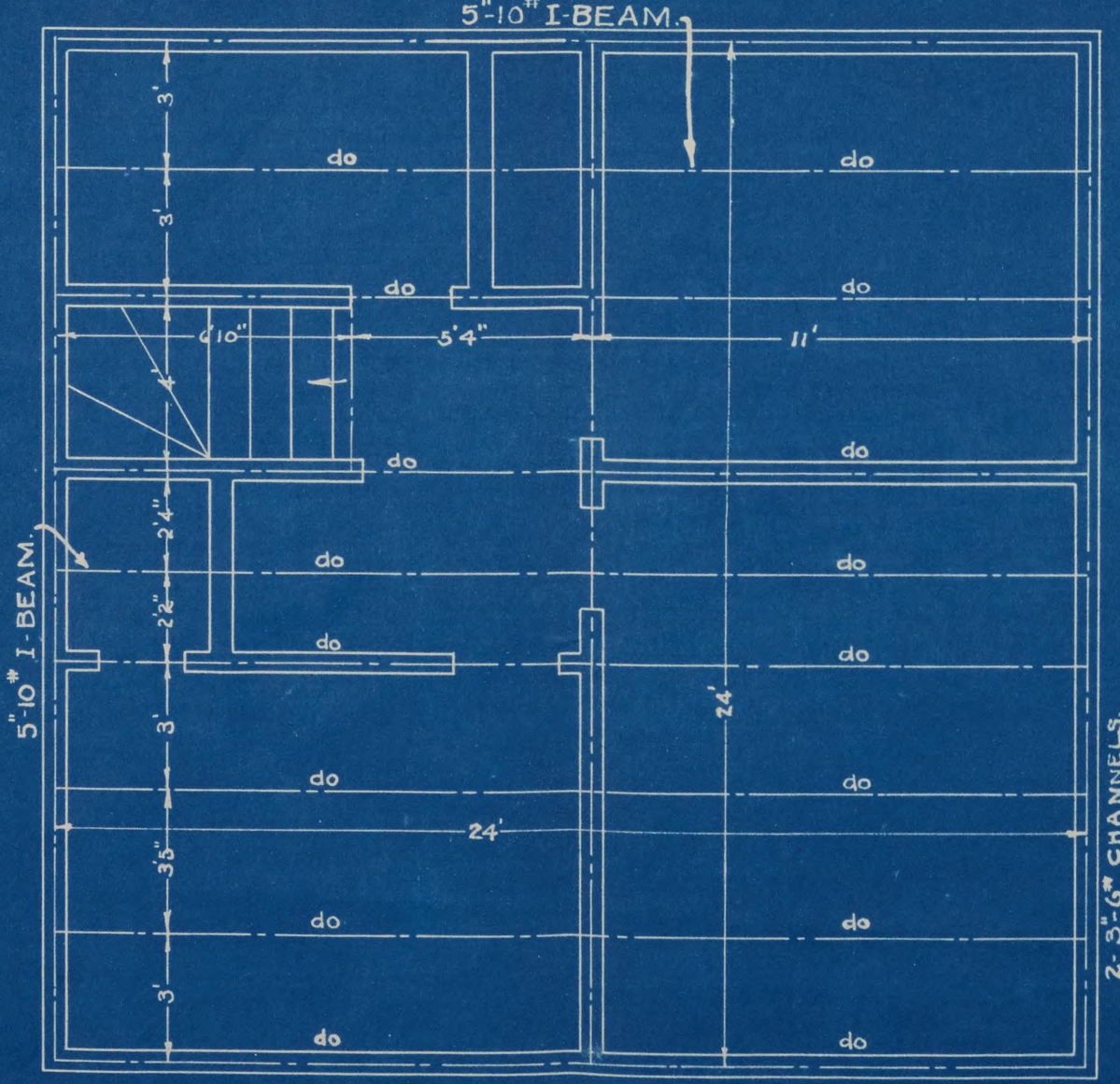


FIRST FLOOR · STEEL PLAN.

SCALE : $\frac{1}{4}$" = 1'0"

V

BERKEL.

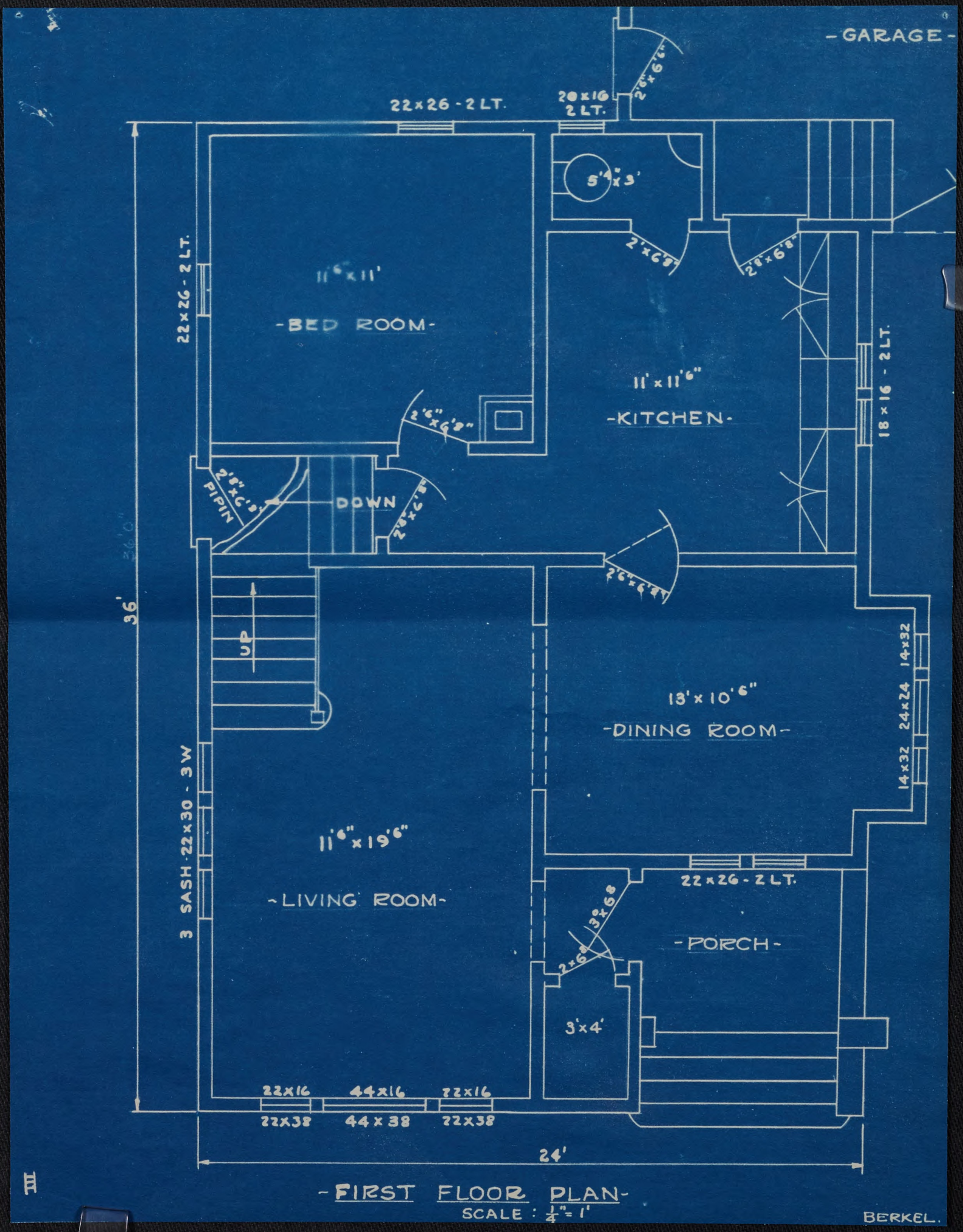


SECOND FLOOR - STEEL PLAN

SCALE: 1/4" = 1'0"

VI

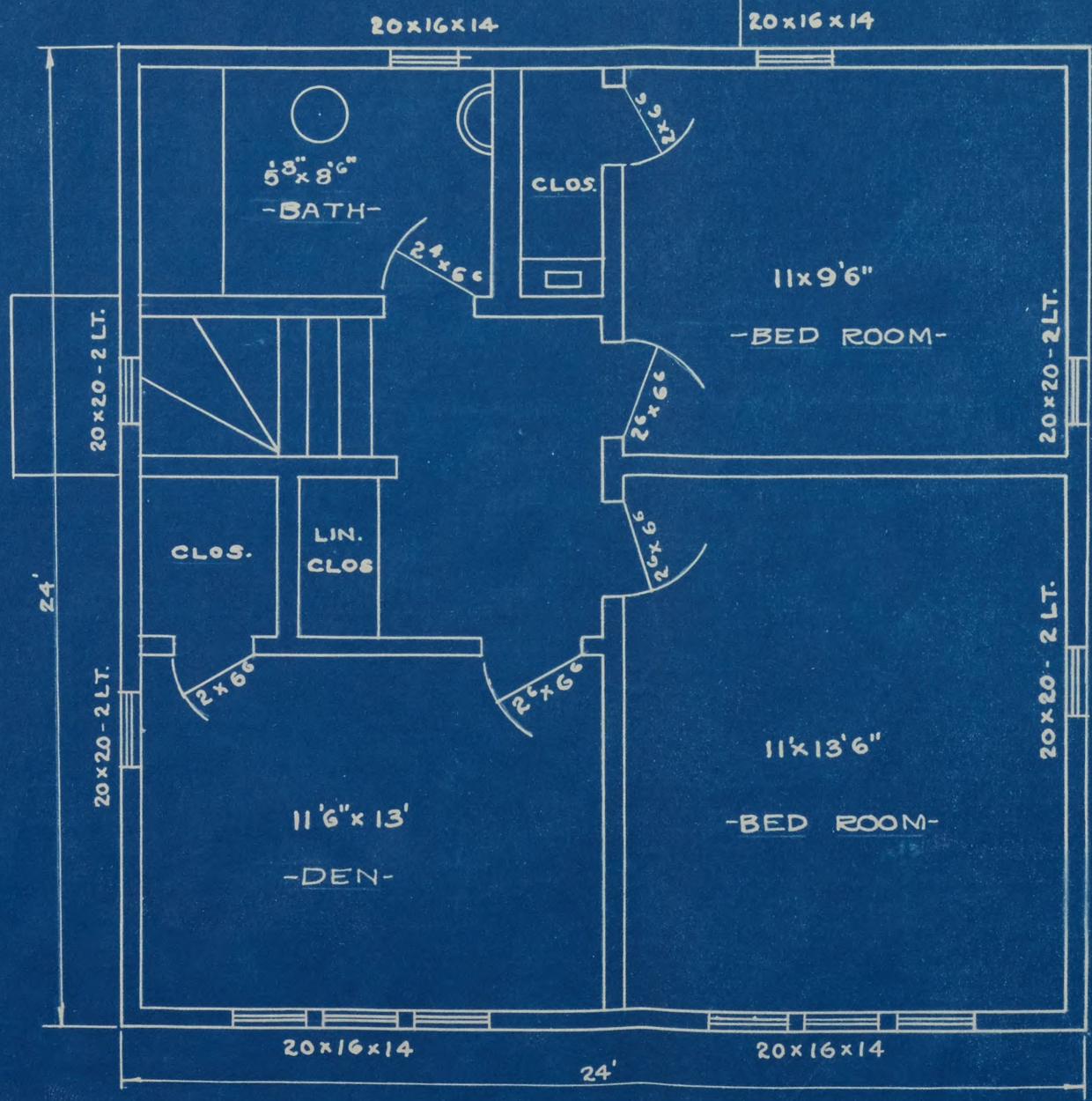
BERKEL.



-FIRST FLOOR PLAN-

SCALE : $\frac{1}{4}$" = 1'

BERKEL.



-SECOND FLOOR PLAN-

SCALE : $\frac{1}{4}$"-1'0"

IV

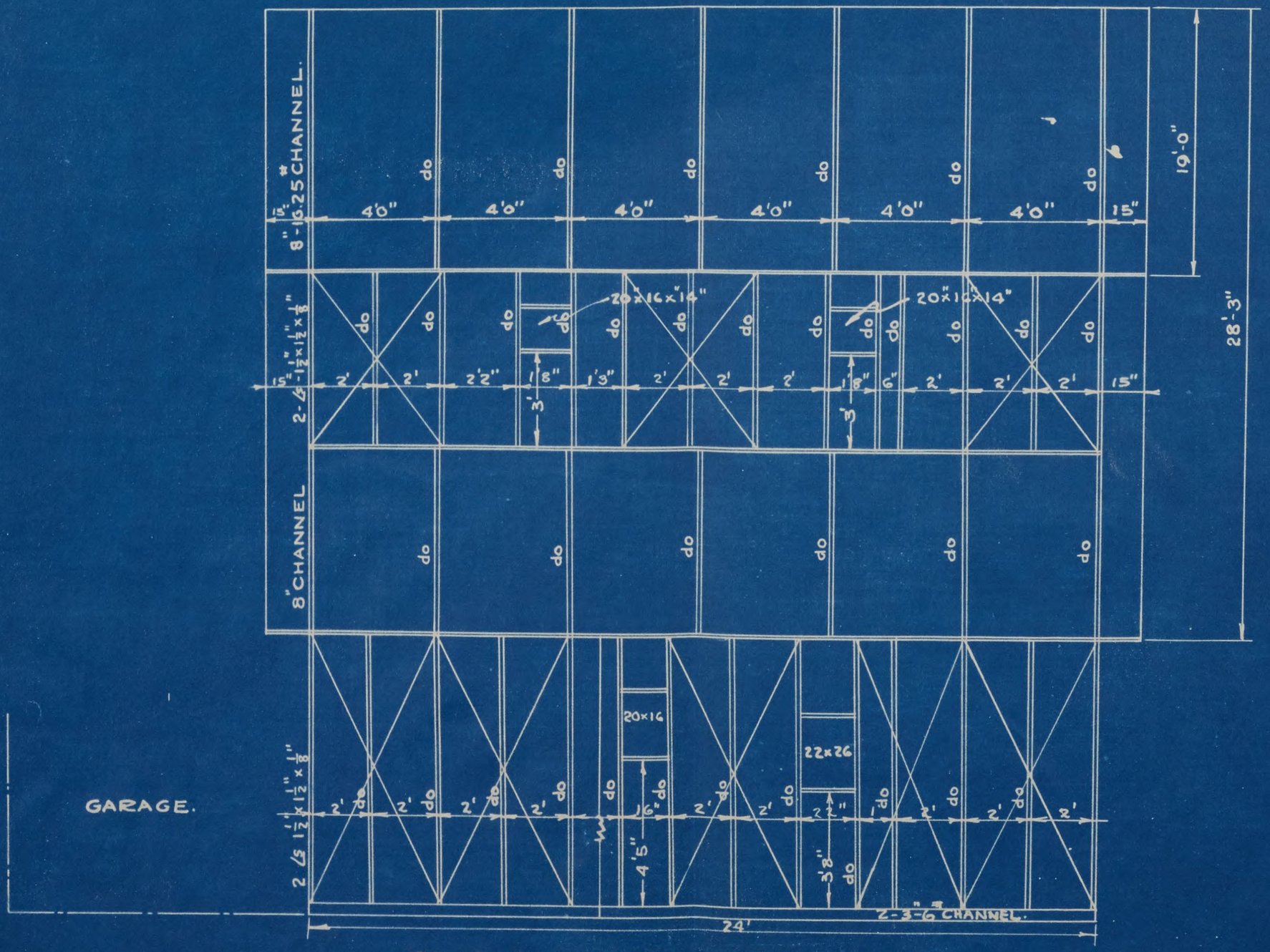
BERKEL.


SIDING
ASPHALT SHINGLES
II
BERKEL.

FRONT ELEVATION

I

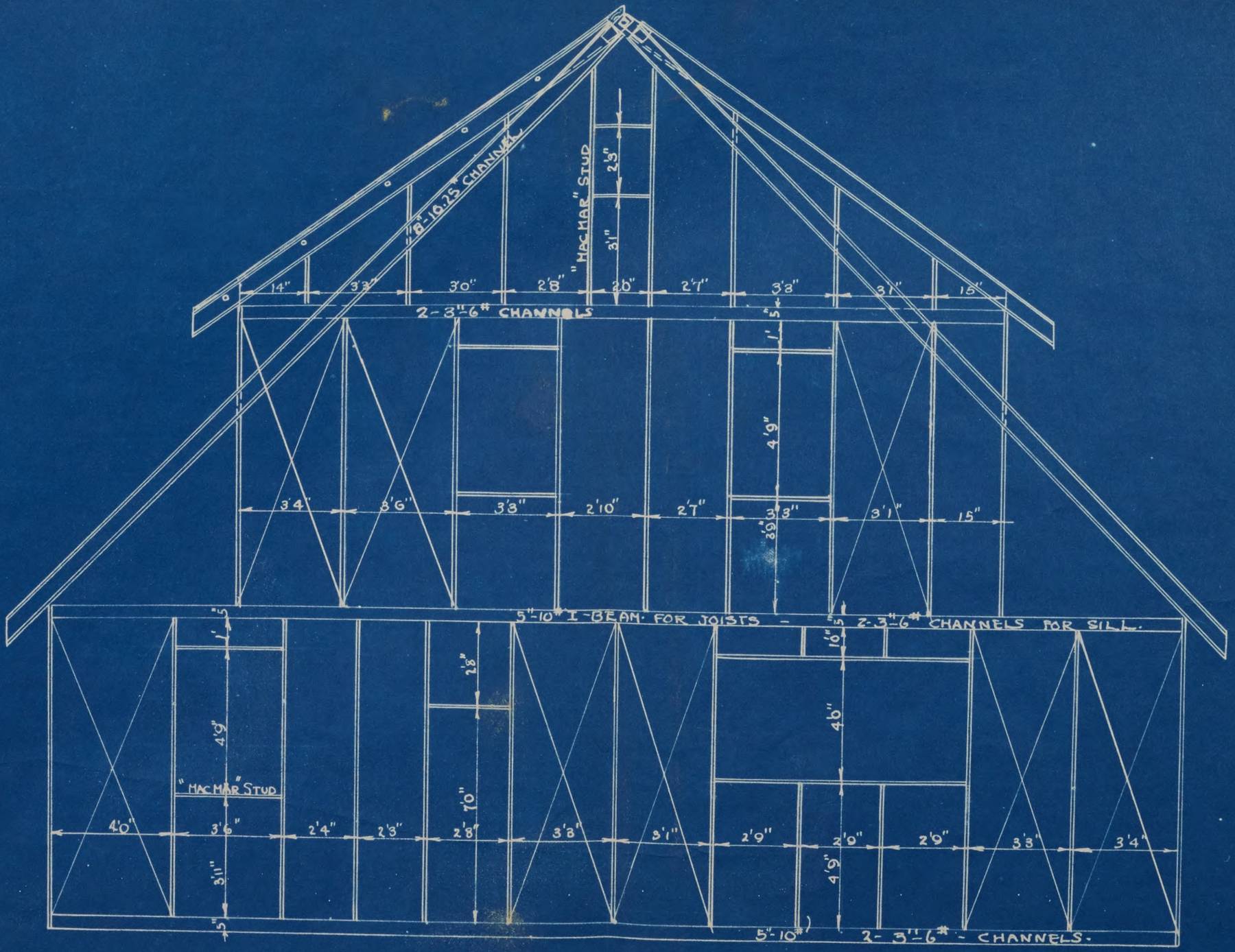
BERKEL.



REAR ELEVATION - STEEL PLAN

SCALE: ¼" = 1'

BERKEL

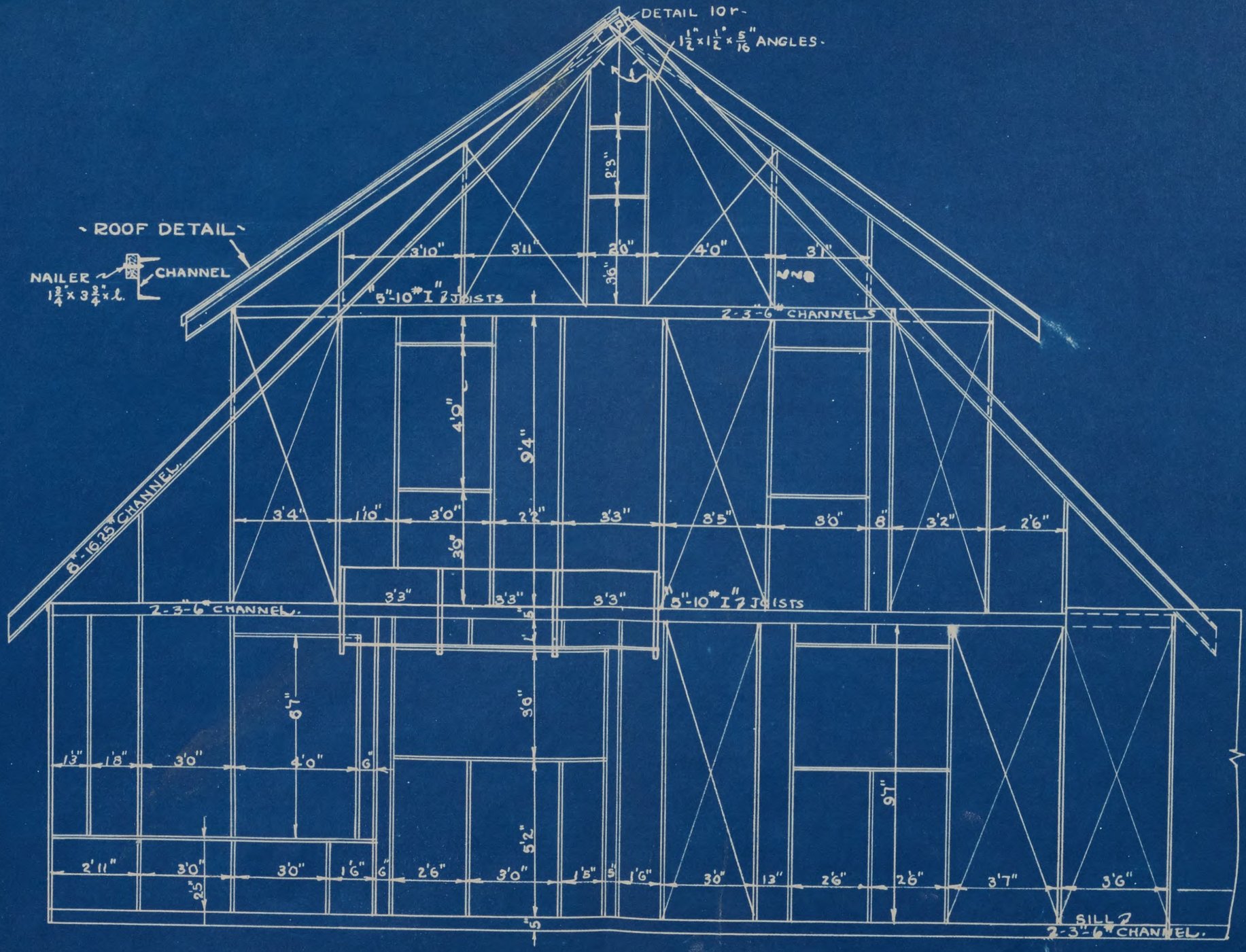


-LEFT ELEVATION- STEEL PLAN-

SCALE: $\frac{1}{4}$"=1'

IX

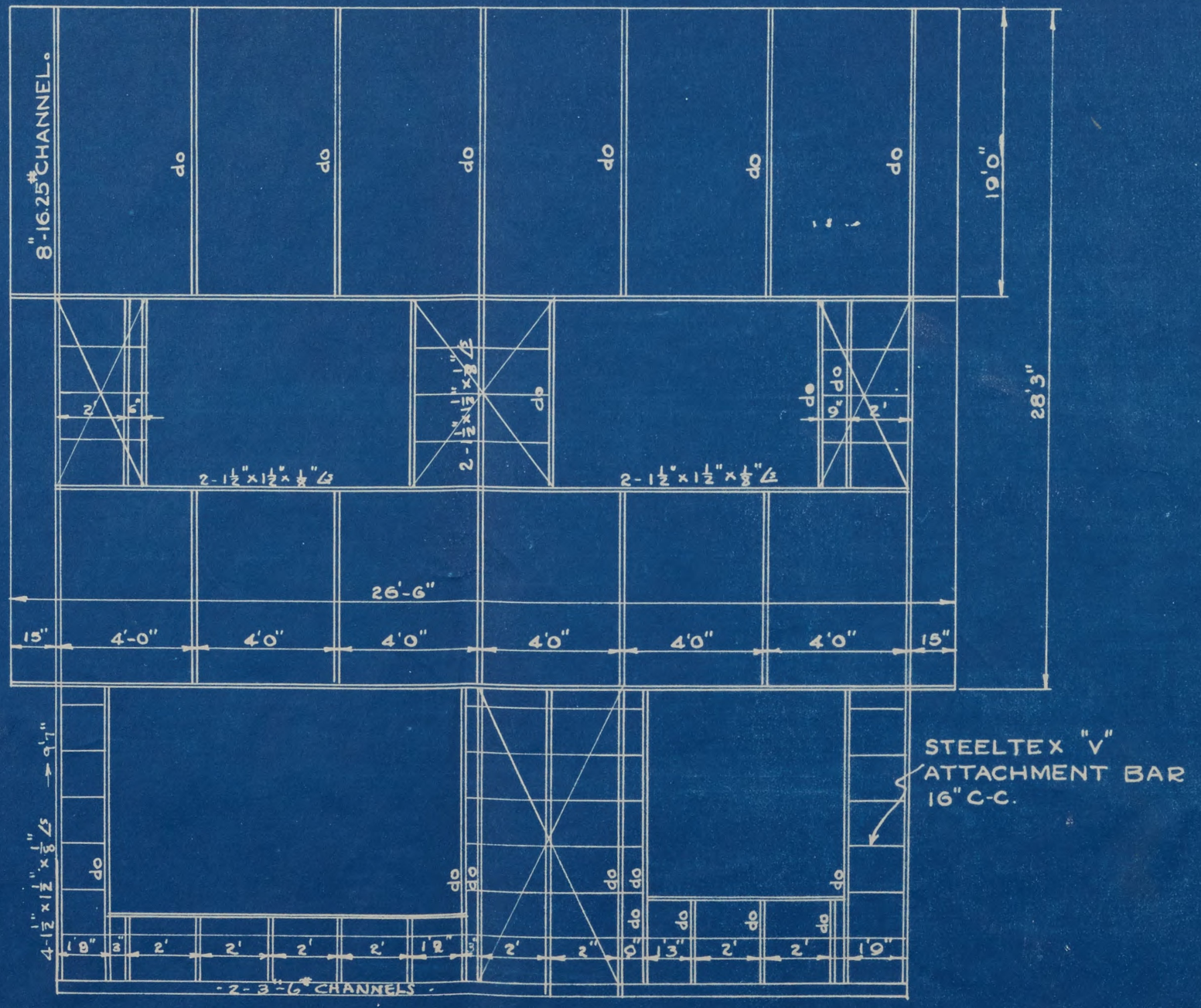
BERKEL



- RIGHT ELEVATION - STEEL PLAN -

SCALE: 1/4" = 1'

VHT
BERKEL-



FRONT ELEVATION · STEEL PLAN.

SCALE : ¼"=1'

VII
BERKEL

Pocket Has:
Blueprints #
1-11