ELI WHITNEY ARMORY: BARN HAER CT-2A

West side of Whitney Avenue, south of Armory Street
Hamden, New Haven County, Connecticut

HAER
CONN,
5-HAM,
3A-

HISTORICAL AND DESCRIPTIVE DATA
PHOTOGRAPHS

Historic American Engineering Record
Office of Archeology and Historic Preservation
National Park Service
United States Department of the Interior
Washington, D.C. 20240

HISTORIC AMERICAN ENGINEERING RECORD

HAER
CONN,
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3A-

ELI WHITNEY ARMORY: BARN
HAER CT-2A

Location:	West side of Whitney Avenue, south of Armory Street Hamden, New Haven County, Connecticut UTM: 18.674710.4577940
Date of construction:	1816
Significance:	Largest surviving structure built by Eli Whitney and an example of his ability as a designer and his careful attention to detail.
Date of this report:	July 1974, by James Vaseff

This report must be read in conjunction with the other HAER material for the Eli Whitney Armory:

	Identification number
Site	HAER CT-2
Forge Building	HAER CT-2B
Fuel Storage Shed	HAER CT-2C
Boarding House	HAER CT-2D

STRUCTURAL STUDY

This analysis begins where it should, with the foundation. The stone masonry is well crafted and sound. The design of this foundation is a primary reason for the soundness of the rest of the structure. Its design was intended to minimize the settling of individual columns by placing column bearing points on continuous walls. The interior columns do not rest on individual piers, which was common practice, but on walls which are perpendicular to and attached to one of the continuous walls. Because these walls are attached, they evenly distribute the column loads, and by supporting each other, greatly minimize the chance of any single column bearing point settling in a different manner than the others. There is one exception to this foundation plan, where one bearing point rests on top of the stone stair, but this stair is much larger than an individual pier would need to be and apparently has not settled more than the other walls. A look at the straight roof peak will show the integrity of the barn's foundation.

The structure above the foundation is an example of simplicity of construction and economy of materials. For ease of explanation, the barn in the attached drawings is shown with three lettered bays running perpendicular to seven numbered bays. Columns rest at intersections of these column lines and are 7-1/2 inches square. Research by the team historians indicates that the barn timbers are either hemlock or spruce and may have been supplied by a Mr. Josiah Stebbins from Maine. The structural members are very sound with no or few imperfections.

All structural members are repetitive and were pre-cut to very close tolerances. This facilitates ease of construction and, depending on the source of material, minimizes waste. (E.g., today wood construction is best designed on a 4-foot module because lumber comes in lengths 8 feet and longer in 4-foot increments -- 8, 12, 16, etc.)

All structural connections in this timber construction are fastened with wooden pegs through mortised connections where appropriate. This type of connection is simple and easy to use as long as it is used in one plane. Mortised and pegged connections in two or more planes in this structure would make the joints more complex

and add to the number of different sized members. It appears that the structural design of this barn kept the construction simplified by keeping the joints on one plane. Thus the barn has eight column lines which are parallel and, in a quick glance, do not appear to connect with each other. More on this following.

The major structural loads in this barn are: 1) load of stored contents; 2) weight of the structure; 3) load from snow and wind.

The load of stored contents is supported on the two floors in bays A and C. Both floors are strong with thick floorboards and short-span heavy joists. The A bay rests on the foundation walls; the C bay is only 4 feet up on the columns and in fact strengthens them by offering lateral support. The weight of the structure, as well as snow loads, is easily supported by the barn's large members.

The live load of wind is most interesting and would cause the most problems in a large building such as this barn. Given that the main structural joints are kept in only one plane, these planes are constructed perpendicular to the largest exterior surfaces (north and south walls) to resist the strongest wind forces. The main horizontal beams are continuous and made of one piece 43 feet long. It is solidly braced on its plane at four locations by diagonal members located 3 feet out from each column joint. These diagonals make a very rigid connection at each column, add to the beam's resistance to bending, and shorten the effective length of the columns by 1/5 in the A bay and 1/4 in the C bay, thus allowing these columns to bear more load (see schematic end elevation).

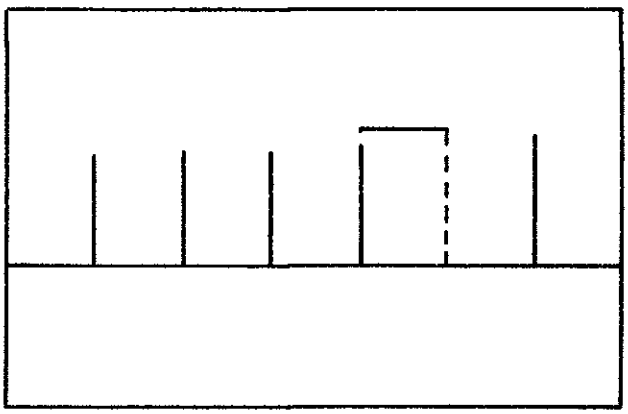
In the center bay above the large beam is a pair of 5-7/8-inch columns joined by a horizontal member with diagonal braces located 2 feet from the beam and column intersection. This element, which imitates the larger ones in the A and C bays below, takes the weight of the roof down to the larger columns and also receives a large part of the lateral wind load of the roof. Below this center bay, the 43-foot beam does not take any vertical load. At first glance, this beam appears to be useless there, but it serves a valuable function by being continuous across the width of the barn. By tying the A and C bays together, this beam gives the barn rigidity by making each column line act as a truss to resist the lateral wind loads.

The barn is adequately braced against racking in its cross section; in the longitudinal section the structure may appear "skimped" for the sake of economy, but it is not. The east and west walls are

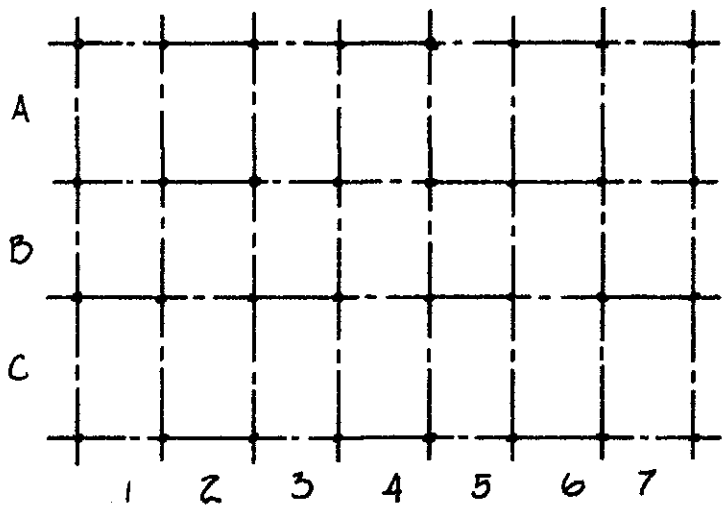
much smaller in area than the north and south and have less wind pressure bearing against them. The eight column lines are tied together, but not in the center where structural members would be fitted with difficulty. The eight planes are connected along the walls and the roof. The large sill plate for the rafters is a nearly continuous member with strong pegged joints where it meets each column, as do the three intermediate members below it. These structural pieces also serve as the nailing and stud pieces of the exterior wall. There are also diagonal members from the sill plate to the columns, which add to the stiffness of these connections (see side elevation). The joists at the 1/5 points in the roof rest on top of their columns and butt each other, thus transmitting the forces from the ends of the barn along to all seven bays. The walls and roof may also act as a membrane to help resist racking in the longitudinal direction.

The Whitney barn is a structure that was well planned and constructed, put together in a simple and economical manner without sacrifice to the structural demands put upon it. Its sound condition some one hundred fifty years after its initial erection is evidence of its structural integrity.

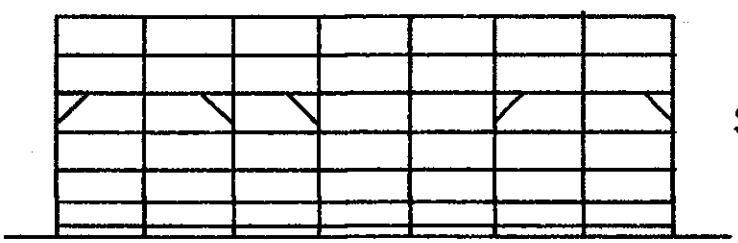
Prepared by James Vaseff
July 1974



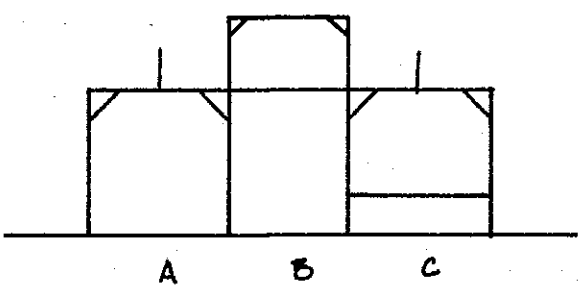
FOUNDATION PLAN



COLUMN PLAN



SIDE ELEVATION

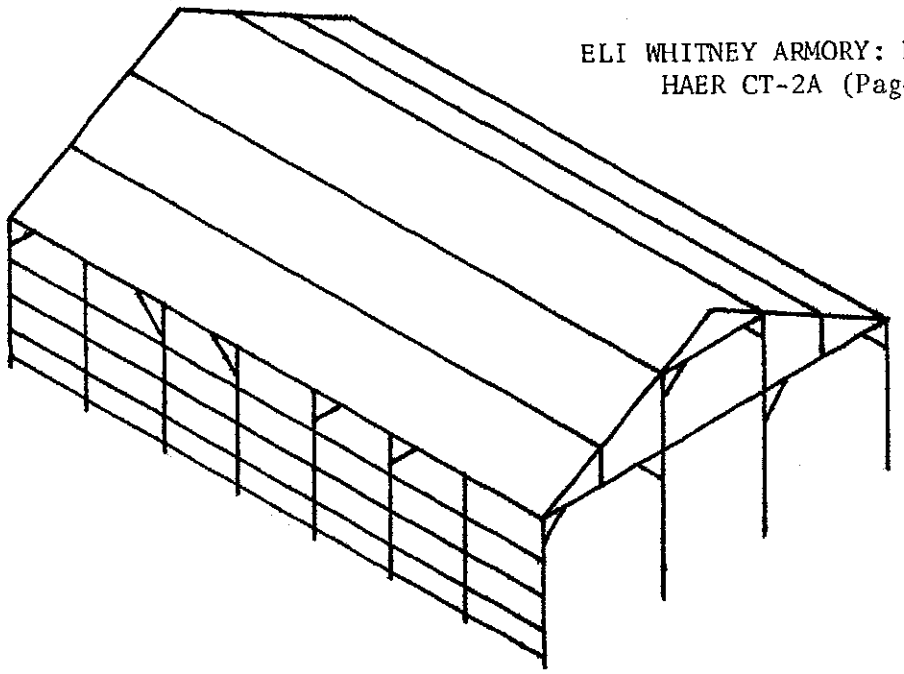


END ELEVATION

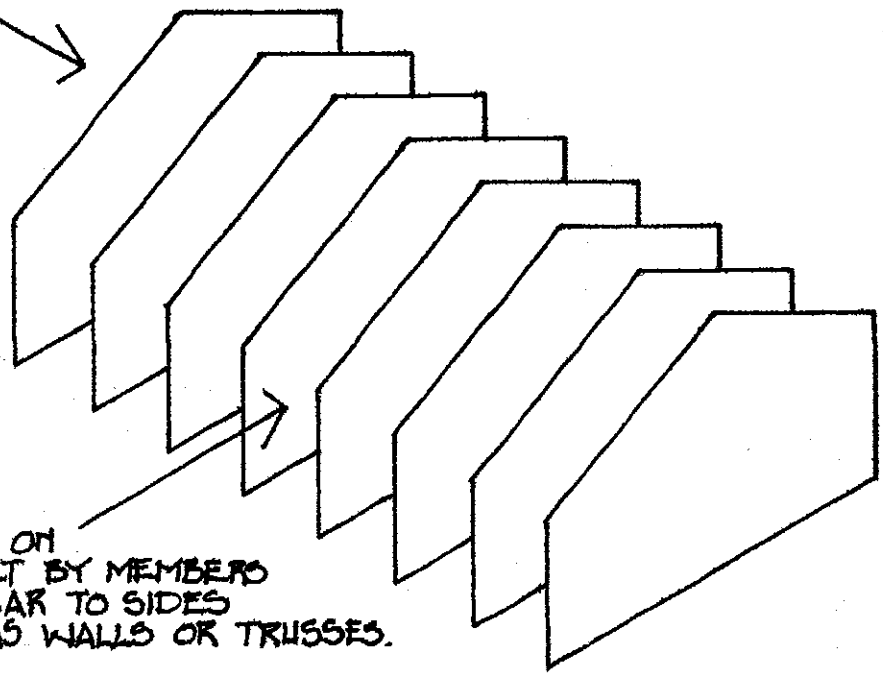
ELI WHITNEY BARN

SCHEMATIC STRUCTURAL DRAWINGS

JAMES VASEFF



WIND FORCES ON ENDS ARE MET BY TYING INNER MEMBERS TOGETHER ALONG THEIR EXTERIOR SURFACES



WIND FORCES ON SIDES ARE MET BY MEMBERS PERPENDICULAR TO SIDES AND ACTING AS WALLS OR TRUSSES.

ELI WHITNEY BARN

SCHEMATIC STRUCTURAL DRAWINGS

JAMES VASEFF

ADDENDUM TO:
ELI WHITNEY ARMORY, BARN
Whitney Avenue
Hamden
New Haven County
Connecticut

HAER CT-2-A
HAER CONN,5-HAM,3A-

FIELD RECORDS

HISTORIC AMERICAN ENGINEERING RECORD
National Park Service
U.S. Department of the Interior
1849 C Street NW
Washington, DC 20240-0001