COMPOSITE BAMBOO FOAM PLANK

IN THE PROYECTO EXPERIMENTAL HOUSE, the second floor and roof structure are bamboo/polyurethane foam sandwich planks laid over beams. The outer skins of the plank sandwich are made of 6 cm bamboos, and the core is two lbs.density polyurethane. A sand-sulphur topping is poured after planks are in position to form the upper walking surface, and the jointing between planks (see page 214).

The planks are 15 cm thick (including the topping), 50 cm wide and 5 meters long. They are supported by similarly constructed beams (see page 204) spaced at intervals between 1

meter and 2.40 meters, according to position in the structure. Since planks are 5 meters long, they act as continuous members over at least two supports after the topping is poured over them. If families do not like the exposed bamboo, the plank will readily take plaster.

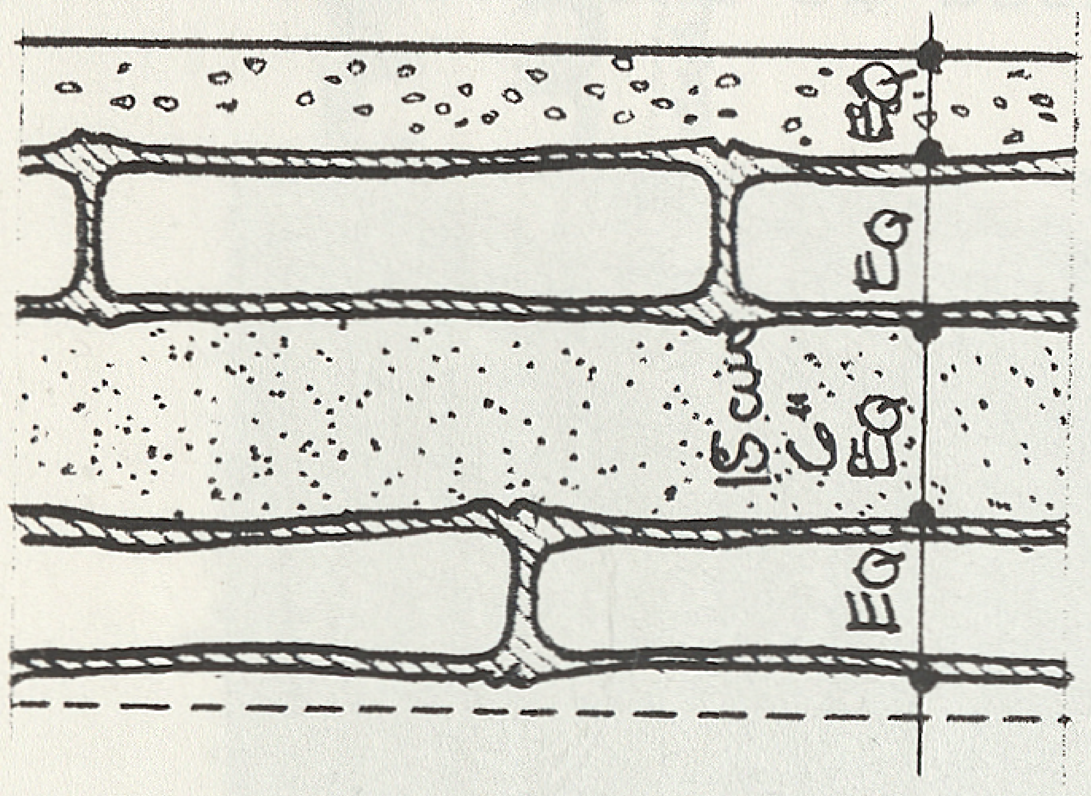
THE GENERAL PATTERN IS:

Context:

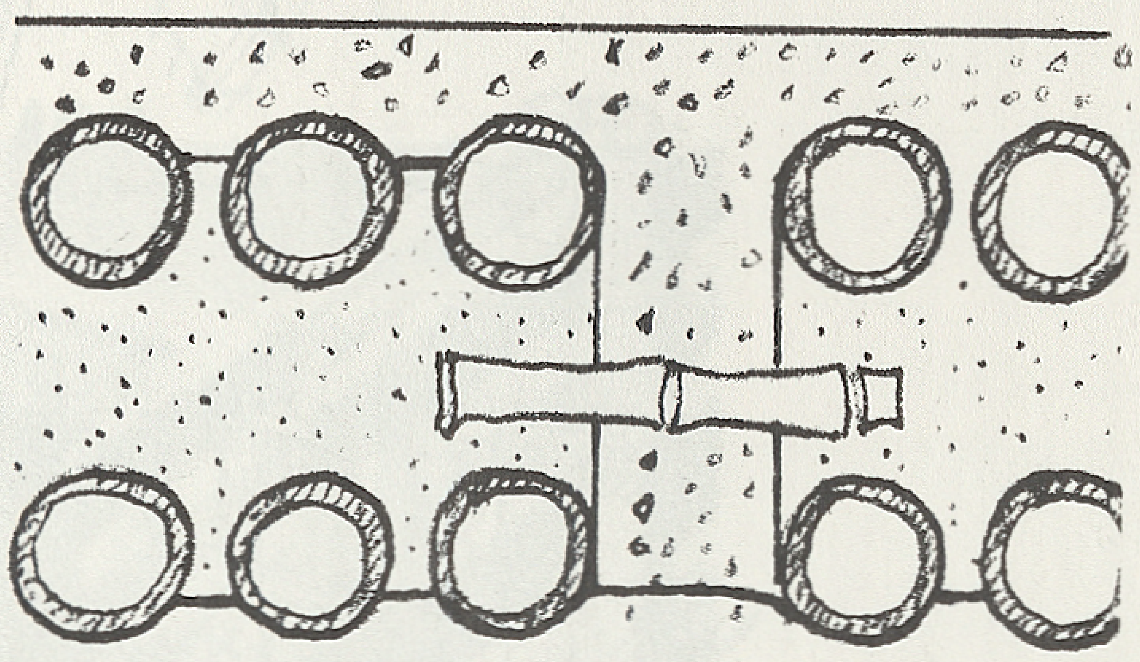
Short beam spacings and light loads in countries where bamboo is abundant and cheap, compared to other materials.

Solution:

Floor and roof planks may be made from bamboo/polyurethane foam sandwich. Maximum span for this system is approximately 2.50 meters unless panels have additional thickness and reinforcing. Allowable loads are shown in the problem statement.



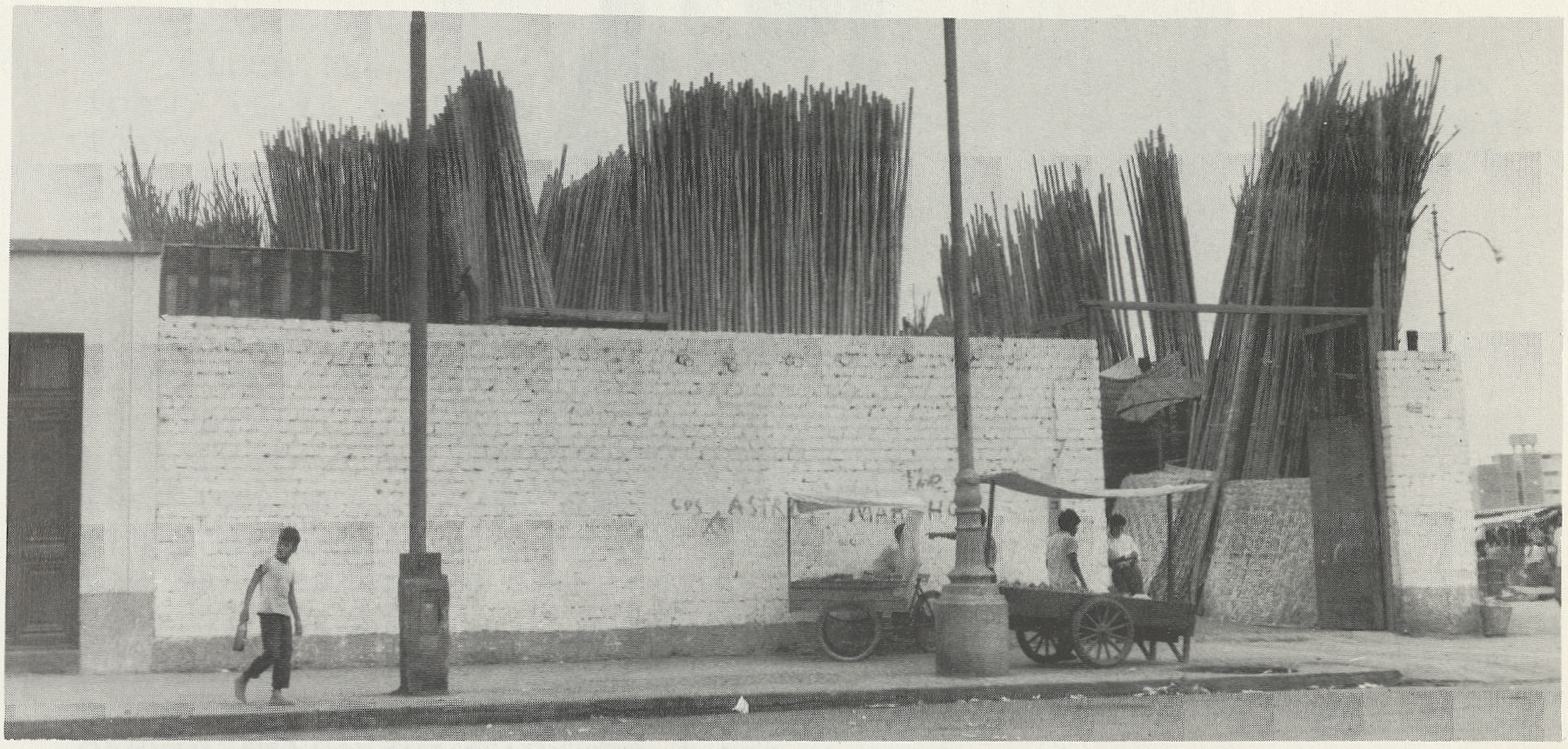
Plank Section



Plank Joint

Problem:

Conventional reinforced concrete beam and plank is expensive and heavy. A number of recent experiments have shown that sandwich planks with plywood, gypsum or cement asbestos skins and polyurethane foam cores have enough strength to span 2-3 meters with normal live loads; they have been widely built and tested in many parts of the United States. In a country where bamboo is readily available, and wood expensive, it seems natural to use bamboo as the outer skin of the sandwich instead of plywood.

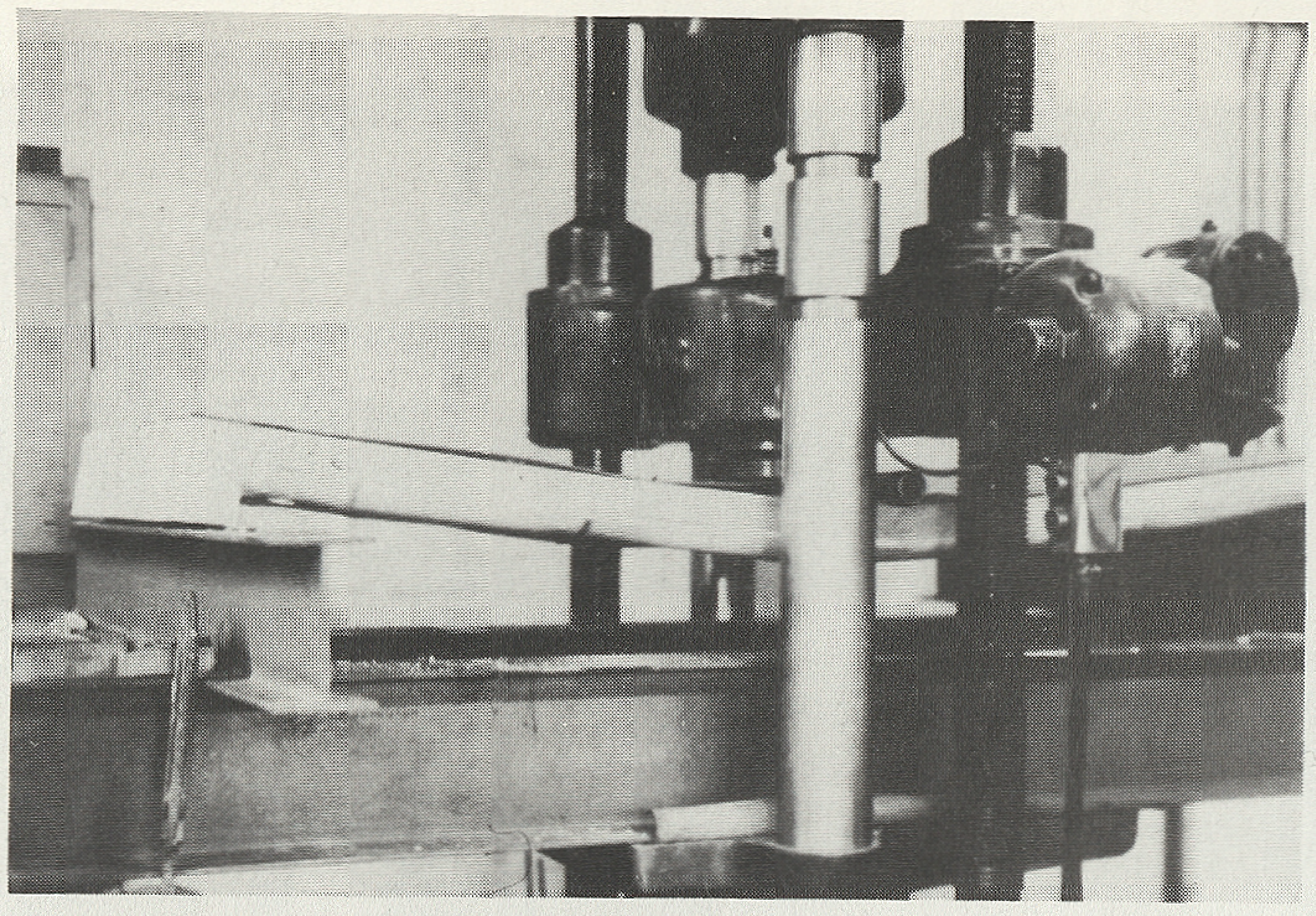


We built a test plank, with half bamboos for the lower skin, and 3 mm fiber board for the upper skin. This plank performed very well in tests. At final failure the upper skin failed, in shear; the bamboo held. The following table shows the deflection test data.

These figures are for a center load, on a plank 70 cm wide, over a span of 170 cm.

Load (kg)	Deflection (cm)
45	.25
91	.50
136	.75
182	.95
227	1.15
272	1.30
318	1.50
364	1.70
409	1.90
454	2.10
546	2.55
636	3.00
729	3.50

This rudimentary plank, which has half bamboos in the lower skin, and very little in the upper, is too weak. We recommend a stronger plank, which has whole bamboos top and bottom.



By means of the formula

$$\text{Deflection}_{Max} = (1/48)WL^3/EI$$

we may obtain a value of EI for the weaker plank. Reckoning that the moment of inertia will be tripled in a plank with whole bamboos top and bottom, we estimate that the stronger plank will support the following loads, at the stated spans:

Clear span between supports (meters)	Maximum allowable uniformly distributed load, for plank deflection less than L/360 (kgs/m^2)
1.00	2000
1.50	590
2.00	250
2.50	128
3.00	74

These planks are extremely light: they weigh about 1.3 kilograms/m^2, they can be hand carried, and laid by two men. Since they can easily be made in long lengths, it is advisable to lay them over several supports, thus getting the benefit of the negative moments. The urethane core gives them excellent thermal and acoustic performance. The foam can also be used as base for applying plaster or can be painted when desired.

Since the plank relies heavily on the use of polyurethane foam, it is important to add a note on the manufacture of these foams: particularly since the countries which are most likely to benefit from the use of bamboo, like Peru, will have to create urethane manufacturing capacity from scratch.

Capital equipment will cost $50,000 to $100,000. The organization of the factory and one year's operation will cost $200 000 - $250,000; with $100,000 of this amount going for the initial inventory of raw materials. At these costs it will be important to use polyurethane foams for other purposes too. They can be used for beams (see page 204) e.g., for interior partitions, and in a slightly different chemical formulation, for the manufacture of furniture, bedding and soft seating. For a general discussion of urethane foams in building, see Structural Potential of Foam Plastics for Housing in Underdeveloped Areas, Architectural Research Laboratory, University of Michigan, Ann Arbor, Michigan, November 1965.