TECHNICAL NOTES

USDA-Natural Resources Conservation Service
Boise, Idaho

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DESIGN CONSIDERATIONS FOR CONCRETE BLOCK STRUCTURES

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Because of an increasing demand for the use of concrete blocks for earth and water control structures, we have prepared the following information concerning design considerations.

In general, the structural design of concrete block structures is the same as for reinforced concrete. Because of the nature of the materials however, some limitations must be recognized by the designer:

1. Transverse or vertical reinforcing steel must be placed through the holes in the blocks. This steel should be designed to resist all stresses from internal and external loadings on the structure. The design depth, d, from the extreme compression fiber to the centroid of the tension reinforcement shall be considered to be equal to one half the block thickness.

2. Longitudinal or horizontal steel will be included in all concrete block structures to resist temperature stresses. The percentage of steel will be the same as required for reinforced concrete in the National Engineering Handbook, Section 6, Page 6.4-2.

   The best way to place this steel is by using beam blocks which are manufactured with a notch for the horizontal steel (see Figures 1 and 2).

   For example, for an 8 inch thick wall, the normal steel requirement is 0.29 square inches of temperature steel per square foot of wall. Two number four bars placed side by side in every other course of blocks will provide the required amount of reinforcement. The contractor could alternate courses of beam blocks with courses of standard blocks.

3. If a concrete block wall exceeds 30 feet in length, then a contraction-expansion joint is required just as in reinforced concrete walls. Alignment can be maintained by using tongue and groove or keyed joints. A dowelled joint may also be used. Reinforcing steel is not continued through the joint. Building paper is commonly used to prevent bond between the blocks and the concrete poured in the hole at the joint. A non-hardening mastic is used to make a water tight joint in place of the mortar used between other blocks in the wall. See Figure 3 for alternate methods of constructing contraction-expansion joints.

4. All exposed concrete block surfaces should be painted with water proofing paints if water tightness is needed.

5. Concrete blocks are manufactured under ASTM procedures which require a compressive strength, f'_c, equal to 2,500 psi. For design purposes, then, we will use 2,500 psi in all structures of concrete blocks. So called "cinder blocks" or blocks with porous aggregate will not be permitted in hydraulic structures.

DESIGN EXAMPLE

Given:
1. Wall height, h, = 6.0' (use cantilever design)
2. Lateral earth load = 65 psf.
3. No high water table.
4. No surcharge.
5. Wall thickness = 8" (standard block thickness).

Find Steel Requirements

Vertical

$$M_o = \frac{\gamma h^3}{6} = \frac{65\ (6)^3}{6} = 2{,}340 \text{ ft. lbs.}$$

From ES-161, NEH Section 6, f'_c = 2,500 psi and d = 4"

Area of steel, A_s, required = 0.40 in^2

Since each block has 2 holes in it, steel must be space at multiples of 8".

From ES-46, NEH Section 6, #5 @ 8" have A_s = 0.46 in^2

Horizontal

.003bt = .288 in^2/ft^2

Use bond beams.

Use 2 #4 bars in every other course which give A_s = 0.29 in^2/ft^2

/s/ H. LeRoy Zollinger
H. LeRoy Zollinger
State Conservation Engineer

Attachments: Figures 1, 2, and 3

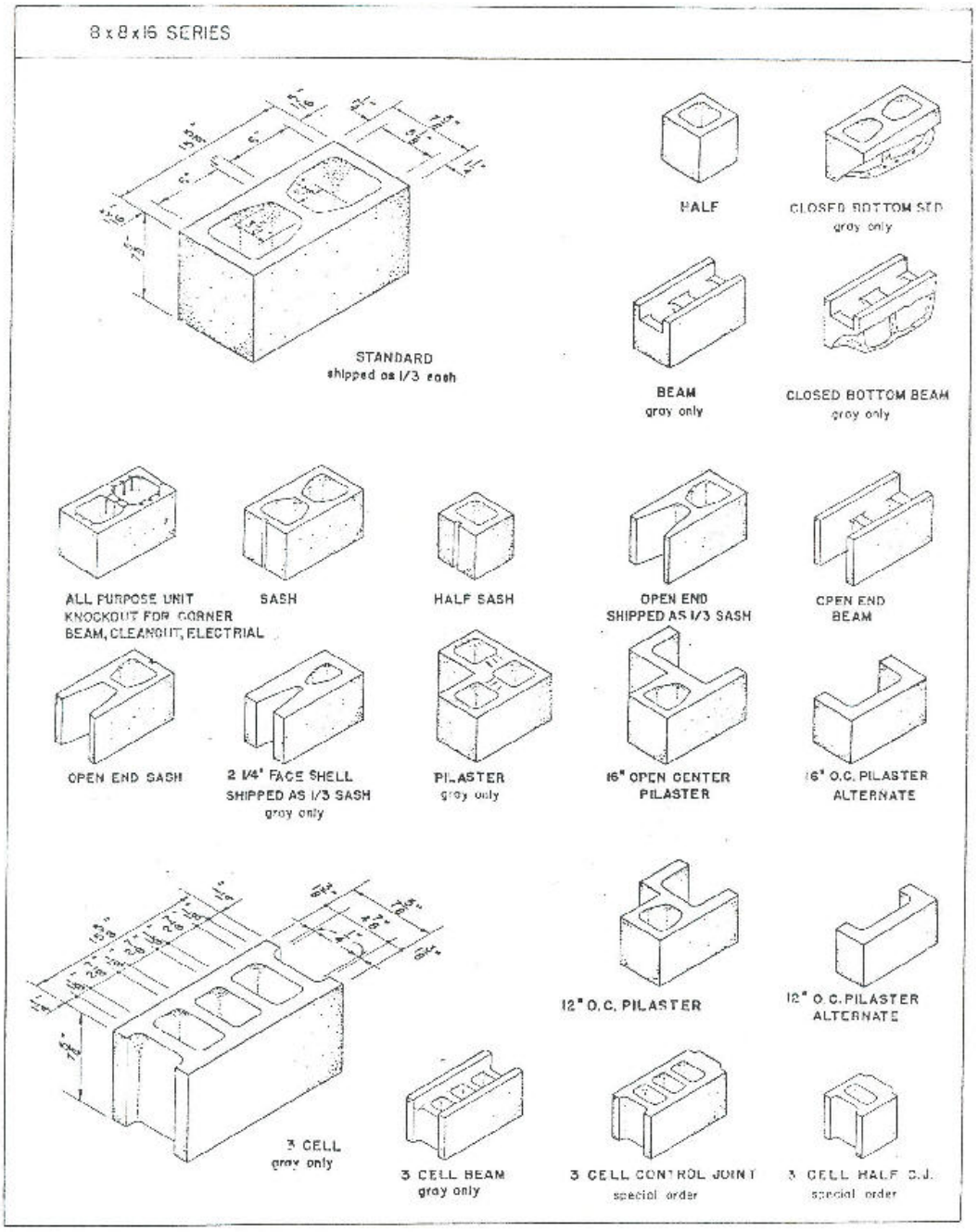

FIGURE 1
Standard Concrete Blocks
(Not all of these types are available from all manufacturers.)

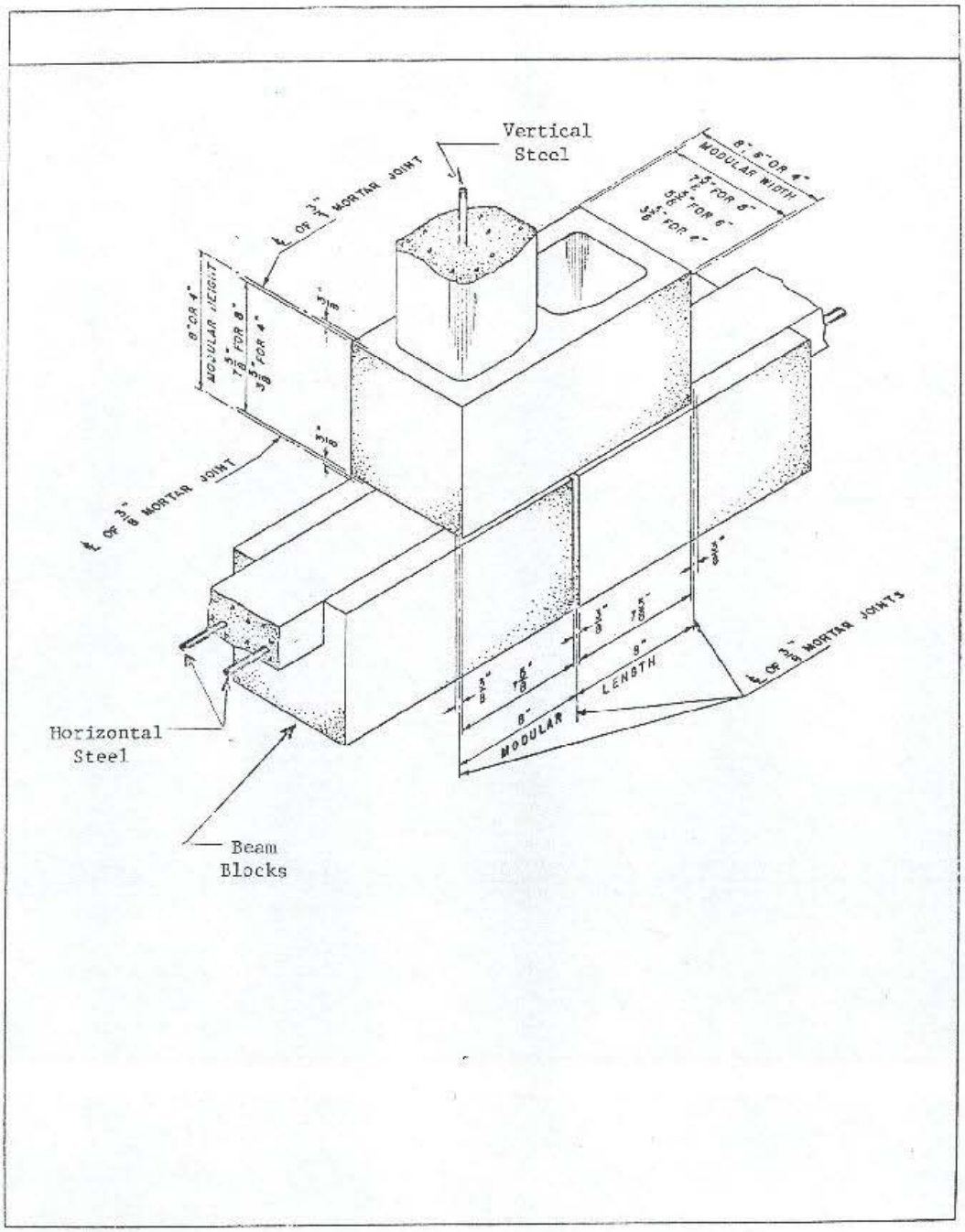

FIGURE 2
Typical Concrete Block Construction

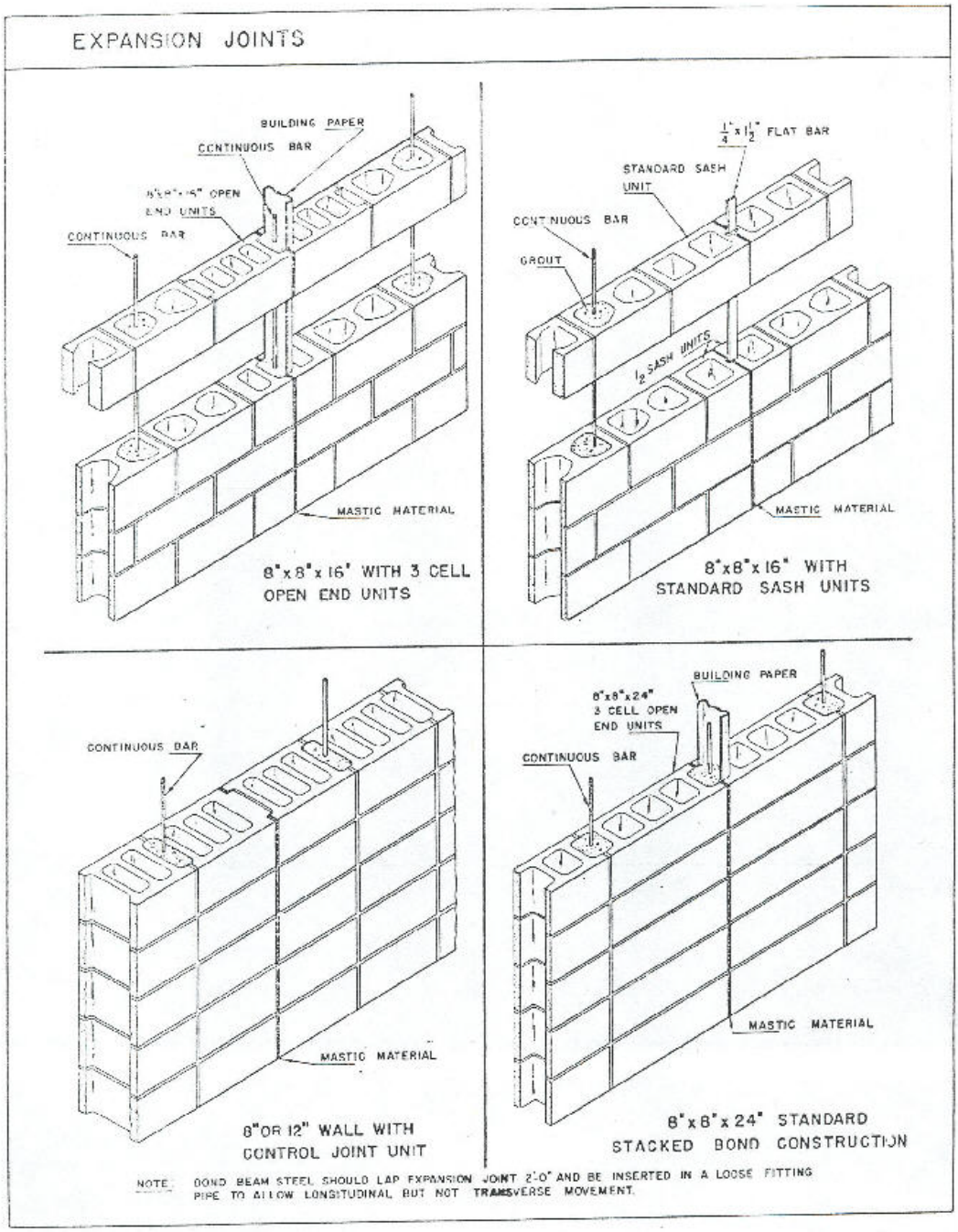

FIGURE 3
Typical Expansion Joint Construction