

Figure 20. Concrete block turned sideways (insect screening shown)

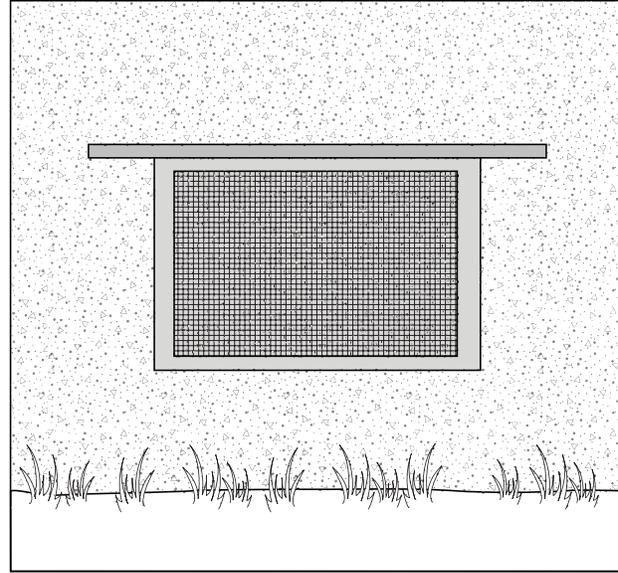


Figure 21. Wood frame with insect screen inserted in opening in poured concrete foundation wall

## Engineered Openings

Openings that are designed and certified by a registered design professional as meeting the performance required by the regulations are called “engineered openings.” This section describes certification and documentation requirements for engineered openings and the specific design requirements.

### Engineered openings with individual certification

For architectural or other reasons, building designers or owners may prefer to use unique or individually designed openings or devices. In these cases, a registered design professional must submit a certification. As a general rule, States require a designer to be licensed to practice in the State in which building is located.

The original certification of the engineered openings must include the design professional’s name, title, address, signature, type of license, license number, the State in which the license was issued, and the signature and applied seal of the certifying registered design professional. The certification shall identify the building in which the engineered openings will be installed. The language of the certification shall address the following:

- A statement certifying that the openings are designed to automatically equalize hydrostatic flood loads on exterior walls by allowing the automatic entry and exit of floodwaters in accordance with the Engineered openings, design requirements on page 26,
- Description of the range of flood characteristics tested or computed for which the certification is valid, such as rates of rise and fall of floodwaters, and
- Description of the installation requirements or limitations that, if not followed, will void the certification.

## Engineered openings with ICC-ES Evaluation Reports

Engineered openings or devices may be accepted by local officials as an alternative to non-engineered openings (prescriptive) provided the designs are certified. The certification may take the form of the individual certification described above, or it can be an Evaluation Report issued by the ICC-ES. The ICC-ES issues such reports for a variety of building products, methods, and materials. Evaluation Reports are issued only after the ICC-ES performs technical evaluations of documentation submitted by a manufacturer, including technical design reports, certifications, and testing that demonstrate code compliance and performance.

ICC-ES has issued *Acceptance Criteria for Automatic Foundation Flood Vents (AC364)* for one type of engineered opening. The ICC-ES will develop acceptance criteria for other types, upon request.

Evaluation Reports are supported by certifications that include appropriate language describing performance of the openings and the name, title, address, type of license, license number, the State in which the license was issued, and the signature and seal of the certifying registered design professional. The specific provisions that are addressed in the certification must include:

Local officials in communities that do not administer the International Code Series determine whether to accept building products that have received Evaluation Reports issued by the ICC-ES.

- A statement certifying that the openings are designed to automatically equalize hydrostatic flood loads on exterior walls by allowing the automatic entry and exit of floodwaters in accordance with the Engineered openings, design requirements below,
- Description of the range of flood characteristics tested or computed for which the certification is valid, such as rates of rise and fall of floodwaters, and
- Description of the installation requirements or limitations that, if not followed, will void the certification.

## Documentation of engineered openings for compliance

An important part of the evidence necessary to document compliance is the certification of engineered openings or the Evaluation Report. A copy of the individual certification or the Evaluation Report is required to be kept in the community's permanent permit files, along with inspection reports. The documentation can be submitted as part of the permit application and design drawings, or submitted separately. Owners should retain the certification or a copy of the Evaluation Report to submit along with applications for NFIP flood insurance.

## Documentation of engineered openings for flood insurance

Insurance agents will request that property owners provide documentation as part of applications for NFIP flood insurance. The documentation should be attached to the Elevation Certificate. The following are acceptable forms of documentation:

- For engineered openings with individual certification, the certification described above that is signed and sealed by a registered design professional who is licensed in the State where the building in which the engineered openings are used is located; or

- For engineered openings with ICC-ES Evaluation Reports, a copy of the Evaluation Report that documents that the engineered openings meet the performance requirements of the NFIP and the building code, and that specifies the number of such openings that are required for a specified square footage of enclosed area below the BFE; or
- For engineered openings with ICC-ES Evaluation Reports, a letter or other written evidence from the local official that use of engineered openings in a specific building is acceptable.

### Engineered openings, design requirements

The American Society of Civil Engineers (ASCE) developed the standard *Flood Resistant Design and Construction* (ASCE 24). This standard applies to buildings and site developments proposed in flood hazard areas; it is referenced by the *International Building Code*. ASCE 24 Section 2.6.2.2 contains installation and design criteria for engineered openings. ASCE 24 provides the equation below to determine the total net area of engineered openings that are installed in foundation walls or enclosure walls. The equation includes a coefficient that corresponds to a factor of safety of 5, which is consistent with design practices related to protection of life and property. This factor of safety also helps to account for the likelihood that insect screens may clog with flood-borne debris. The ASCE 24 commentary provides additional background on the derivation of the equation.

As with non-engineered openings, engineered openings must be designed to allow automatic entry and exit of floodwaters.

Three design and performance criteria for engineered openings are specified in ASCE 24 but are not explicitly identified in the NFIP regulations:

- Engineered openings are to perform such that difference between the exterior and interior water levels shall not exceed 1 foot during base flood conditions.
- Engineered openings are to be not less than 3 inches in any direction in the plane of the wall. This requirement applies to the hole in the wall, excluding any screen, grate, grille, louvers, or devices that may be placed in or over the opening.
- In the absence of reliable data on the rates of rise and fall, engineered openings are to be designed based on the assumption that the minimum rate of rise and fall will be 5 feet per hour. Where data or analyses indicate more rapid rates of rise and fall, the required number of openings is to be increased to account for those different conditions. The number or size of the openings may be decreased if data or analyses indicate rates of rise and fall are less than 5 feet per hour.

From ASCE 24, the equation to determine area of engineered openings:

$$A_o = 0.033 [1/c] R A_e$$

Where:  $A_o$  = total net area of openings required (in<sup>2</sup>)

0.033 = coefficient corresponding to a factor of safety of 5.0 (in<sup>2</sup> • hr/ft<sup>3</sup>)

$c$  = opening coefficient (non-dimensional; see ASCE 24, Table 2-2)

$R$  = worst case rate of rise and fall (ft/hr)

$A_e$  = total enclosed area (ft<sup>2</sup>)

[ASCE 24] Table 2-2  
Flood Opening Coefficient of Discharge

Opening Shape and Condition	$c$
circular, unobstructed during design flood	0.60
rectangular, long axis horizontal, short axis vertical, unobstructed during design flood	0.40 <sup>a</sup>
square, unobstructed during design flood	0.35
rectangular, short axis horizontal, long axis vertical, unobstructed during design flood	0.25 <sup>b</sup>
other shapes, unobstructed during design flood	0.30

Notes:

- a. When the horizontal dimension is twice or more the vertical dimension, use 0.4; as the dimensions approach a square, interpolate from 0.4 to 0.35.
- b. When the horizontal dimension is half or less the vertical dimension, use 0.25; as the dimensions approach a square, interpolate from 0.25 to 0.35.

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