



Ensuring That Structures Built on Fill are Reasonably Safe From Flooding

An Online Continuing Education Course for Engineers

Course Number: BD-2013

Credit: 2 Hours / 2 PDH / 2 CPD

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Introduction

For the purpose of administering the National Flood Insurance Program (NFIP), FEMA identifies and maps flood hazard areas nationwide by conducting flood hazard studies and publishing Flood Insurance Rate Maps (FIRMs). These flood hazard areas, referred to as Special Flood Hazard Areas (SFHAs), are based on a flood having a 1-percent probability of being equaled or exceeded in any given year (also referred to as the 100-year flood or Base Flood).

Structures within the SFHA in a community participating in the NFIP are subject to floodplain management regulations that impact building standards and are designed to minimize flood risk. For example, Title 44, Part 60, Section 3(c)(2) of the Code of Federal Regulations—abbreviated as 44 CFR 60.3(c)(2)—requires that the lowest floor of a residential structure, including basement, built within the SFHA be at or above the Base Flood Elevation (BFE). In addition, flood insurance must be purchased for these structures if they are used as collateral to secure a loan provided by a federally regulated lender. Flood insurance coverage may be purchased for all eligible structures within a participating community. Insurance rates for structures located within the SFHA differ from the rates for structures located outside the SFHA.

When permitted under applicable Federal, state, and local laws, ordinances, and regulations, earthen fill is sometimes placed in an SFHA to reduce flood risk to the filled area. Under certain conditions, when engineered earthen fill is placed within an SFHA to raise the surface of the ground to or above the BFE, a request may be submitted to FEMA to revise the FIRM to indicate that the filled land is outside of the SFHA. When such revisions are warranted, FEMA usually revises the FIRM by issuing a Letter of Map Revision based on fill (LOMR-F). After FEMA has revised the FIRM to show that the filled land is outside the SFHA, the community is no longer required to apply the minimum NFIP floodplain management standards to any structures built on the land and the mandatory flood insurance purchase requirements no longer apply. It is worth noting that states and local communities may have floodplain regulations that are more restrictive than the minimum requirements of the NFIP and may continue to enforce some or all of their floodplain management requirements in areas outside the SFHA.

Although a structure built on a site that has been elevated by the placement of fill may be removed by FEMA from the SFHA, the structure may still be subject to damage during the Base Flood and higher-magnitude floods. Constructing the entire structure at or above the level of the

BFE will minimize the flood risk from the Base Flood and is therefore the most prudent approach to constructing on fill. Conversely, a structure with a basement (subgrade area) adjacent to or near the floodplain may well be impacted by subsurface flooding brought on by surface flooding.

This course provides guidance on the construction of buildings on land elevated above the BFE through the placement of fill. Several methods of construction are discussed, and the most prudent—those that result in the entire building being above the BFE—are recommended.

In some areas of the country, basements are a standard construction feature. Individuals may wish to construct basements on land after it has been removed from the floodplain by a FEMA revision. Buildings with basements built in filled areas are at an added risk of flooding when compared to buildings on other types of foundations. However, there are two major ways to minimize this additional risk from subsurface flooding. First, the building should be located farther back from the edge of the fill closest to the flooding source. Second, the higher the basement floor is elevated, the less the risk. This course provides guidance on how to determine that these buildings will be reasonably safe from flooding during the occurrence of the Base Flood and larger floods. To be reasonably safe from flooding during the Base Flood condition, the basement must (1) be dry, not have any water in it, and (2) be structurally sound, not have loads that either exceed the structural capacity of walls or floors or cause unacceptable deflections. In practice, this means that soils around the basement must have low permeability to minimize or stop water infiltration to the basement wall and floors. Any water that does permeate to the basement must be removed by a drainage layer on the outside (soil side) of the basement. In addition, the foundation walls and floor slab must be designed and constructed for any increased loads that may occur during the Base Flood condition.

NFIP Regulations

Part of a community's application to participate in the NFIP must include "a commitment to recognize and duly evaluate flood hazards in all official actions in the areas having special flood hazards and to take other such official actions reasonably necessary to carry out the objectives of the program" [44 CFR 59.22 (a)(8)].

NFIP regulations at 44 CFR 60 include Subpart A: Requirements for Flood Plain Management Regulations. Each community participating in the NFIP adopts a floodplain management ordinance that meets or exceeds the minimum requirements listed in 44 CFR 60. Subpart A establishes specific criteria for determining the adequacy of a community's floodplain management regulations. The overriding purpose of the floodplain management regulations is to

ensure that participating communities take into account flood hazards, to the extent that they are known, in all official actions relating to land management and use.

One of the minimum requirements established by the regulations is set forth at 44 CFR 60.3 (a)(3), which states that, for all proposed construction or other development within a participating community, the community must “Review all permit applications to determine whether the proposed building sites will be reasonably safe from flooding.” 44 CFR 59.1 defines “development” as

“...any manmade change to improved or unimproved real estate, including but not limited to buildings or other structures, mining, dredging, filling, grading, paving, excavation or drilling operation or storage of equipment or materials,”

Warning

Construction of a residential building in an identified SFHA with a lowest floor below the BFE is a violation of the floodplain management requirements set forth at 44 CFR 60.3(c)(2), unless the community has obtained an exception to NFIP requirements from FEMA and has approved procedures in place.

Note that residual flood hazards may exist in areas elevated above the BFE by the placement of engineered earthen fill. Residual risks in these areas include subsurface flood conditions and flooding from events that exceed the base flood. This is intended to provide guidance on whether structures placed in filled areas are reasonably safe from flooding. FEMA will require that the jurisdiction having authority for floodplain management determine that an area is reasonably safe from flooding before removing it from the SFHA.

Floodways, V Zones, and Alluvial Fan Flood Hazard Areas

This course does not apply to the following:

- Construction in the floodway. The NFIP prohibits encroachments into the floodway that would cause increases in flood stage.
- Construction in SFHAs designated Zone V, VE, or V1-V30 on FIRMs. The NFIP prohibits the use of structural fill for support of buildings in V zones. Buildings constructed in a V zone must be constructed on an open foundation consisting of piles, piers, or posts and must be elevated so that the bottom of the lowest horizontal structural member is at or above the BFE. In addition, this course strongly recommends that structural fill not be used to elevate buildings constructed in A zones in coastal areas.
- Construction in SFHAs subject to alluvial fan flooding (designated Zone A0 with depths and velocities shown on FIRMs). The NFIP will not remove land from the floodplain based on the placement of fill in alluvial fan flood hazard areas.

Notes for Local Officials

Professional Certification

As required by state and local floodplain management ordinances, a proposed development must be determined to be reasonably safe from flooding. The official having the authority to make this determination should require all appropriate information for making the determination. This may include a certification by a qualified design professional that indicates the land or structures to be removed from the SFHA are reasonably safe from flooding. Such a professional certification may come from a professional engineer, professional geologist, professional soil scientist, or other design professional qualified to make such evaluations.

Administrative Options for Community Permitting

Communities may choose a variety of administrative procedures to assist them in gathering information that can be used to determine whether a proposed development is reasonably safe from flooding. Communities are encouraged to establish procedures that alert them to potential future development of a filled area. These procedures should allow for the evaluation of future

development and a means to determine whether it will be reasonably safe from flooding. The following are examples of such procedures:

- Require building sites to be identified on final subdivision plats and evaluate those building sites against appropriate standards.
- Require grading plans as a condition of issuing fill permits and require that those grading plans include building sites, and evaluate those building sites based on appropriate standards.
- Require buffer zones or setback zones around the perimeter of fill pads or at the edge of the floodplain and establish construction requirements within these buffer zones to ensure that buildings are safe from residual flooding.
- Require as a condition of issuing fill permits that the developer agree that no basements will be constructed in buildings immediately adjacent to the fill.
- Adopt or have adopted floodplain management regulations that require that buildings immediately adjacent to floodplains be designed to be safe from flooding. For example, under such regulations, building officials designate areas outside of the floodplain and require that building officials evaluate such areas to determine if an official believes that buildings in such areas are safe from flooding.
- When issuing a fill permit, the permit stipulate that no basements will be constructed in buildings immediately adjacent to the fill.

To view the remainder of the course material and to take the quiz for PDH credit, you must purchase the course.
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Placement of Fill

Properly placing fill requires consideration of soil mechanics, local site conditions, the specific characteristics of the soils being placed, the methods used to place and compact the fill, and soil testing procedures. Standard engineering and soil mechanics texts cover these subjects in detail. The performance of these filled areas should consider, but is not limited to, the following:

- The consolidation of the fill layers and any underlying layers
- The effect of this consolidation on either excessive settlement or differential settlement
- How the permeability of the soils affects water infiltration on any structures built on the site