



Rising Above the Floods



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Introduction

Repetitive flooding affects thousands of Louisiana homes and businesses. Many of the affected structures are built on slabs on the ground; many are brick-veneer construction with fireplaces. Until recently owners of such structures had two elevation options: 1) removal from the slab or 2) perimeter jacking using foundation repair and leveling techniques. Either method, except on the smallest structures, is invasive.

A group of flood victims in Denham Springs, La., near Baton Rouge, persuaded the Amite River Basin Drainage and Water Conservation District to help them bring a slab-raising contractor to Louisiana to demonstrate a non-invasive method on their homes. The project was funded through FEMA's Hazard Mitigation Grant Program with cooperation from the Louisiana Office of Emergency Preparedness, the LSU Agricultural Center's Louisiana Cooperative Extension Service, McKee and Deville Consulting Engineers, the LSU School of Architecture and the City of Denham Springs. The homeowners bore about 45% of the total costs of their projects.

In this publication and its companion videotape, the procedure is explained as it was demonstrated by the Michigan contractor. Special attention is given to adapting the technology for use in Louisiana's floodplains.

As a result of this project, slab elevation is now offered by Louisiana contractors. You can obtain a list of contractors and addresses of elevated structures by calling your parish office of the Louisiana Cooperative Extension Service (listed in the parish government section of the phone book under "Extension Service") or the Louisiana Office of Emergency Preparedness.

Raising a slab-built home with its slab is a major renovation which will affect not only the appearance of your home or business but its structural integrity. The main purpose of this publication is to give you a basic understanding of how it's done and confidence that slabs can be elevated.

This publication also provides tools to help you decide whether to elevate your home or business using this method, and guide you through the planning process. Other valuable resources are listed on the inside back cover.

Are you allowed?

Elevation of a slab-built structure is "construction" or "development" in the legal sense of those words and may be "substantial" as defined in local building ordinances. In most communities and in all designated flood hazard areas, it will be subject to local ordinances and the building permit system. If you live in a subdivision, your building modifications may also be subject to subdivision restrictions or covenants.

One of your first stops when considering structure elevation should be the local building or permit office. They may be able to offer advice, and they should be able to answer these important questions:

Are you in a designated special flood hazard area ("the flood zone")?

What is the Base Flood Elevation (BFE) at your building site?

Do local ordinances or building codes govern elevation of an existing building?

Are you subject to any subdivision restrictions or covenants?

Do you need a permit, and how do you get one?

Does the local government have any programs to assist homeowners with flood proofing?

Your mortgage company has a financial interest in your building and should be consulted.



The Slab

Ground-level building slabs in Louisiana are from 4 inches thick for residences to 6 to 8 inches thick for light commercial structures. A slab is poured as a single piece (monolithic) with thicker areas called footings and grade beams around the edges and under load-bearing interior walls. In residential construction, especially where there are no building codes or where codes are not enforced through an inspection system, slabs may not be reinforced very well.

The weight of the house, including walls, roof and interior furnishings, is transferred to the slab. The slab transfers the weight of the building, and its own weight, to the ground. When you lift a slab off the ground, you change the way the slab is supported. It takes a professional engineer and an experienced structural mover to do this correctly.

Take the slab, or leave it?

Your house was designed to be supported by a slab, so it's intuitive that an elevation method which retains the slab will have the least structural impact on the house itself. Brick veneer and fireplaces are typically held up by the slab. Floor covering, toilets, bathtubs and built-in cabinets are either attached to the slab or depend on it for support. When you take a house off its slab, you lose some structural items such as tile floors. Other items, such as toilets, have to be reinstalled. Everything must be removed from the house, and repairs will have to be made to holes in exterior and interior walls where bracing is used.

By contrast, a house raised on its slab is completely sealed against the elements. Furniture, appliances and personal belongings remain undisturbed. There's no need to move or store anything. It's even

possible to maintain electrical service during construction if the contractor's insurance allows and proper grounding is established.

In raising a slab, you'll face a different set of problems than you face in taking a house off the slab. The method used in the Denham Springs project involves removing all the dirt from beneath the structure. This may seem extreme, but the full access gained in this process allows the contractor to provide support for the slab over its entire area, including multiple slabs, varying slab thickness and separate foundations for masonry fireplaces. The method does not rely on the inherent strength of the slab.

While your house remains completely intact, your yard is turned literally upside down. Some of the restoration expense can be avoided by removing and storing sod and valuable landscaping plants before construction. The impact of rain during construction can be greater when elevating a slab than when removing the house from a slab. This is especially true in Louisiana floodplains, as explained on page 13.

When the slab is raised, or when the house is removed from the slab, the insulating effects of the earth are lost. The extent of heat loss through the slabs elevated in this project has not been quantified, but it is recommended that homeowners add insulation to the bottom of the original slab.

Slab elevation contractors have a larger investment in equipment and machinery than do most traditional housemovers. Few contractors have slab elevation expertise. As a result, there is limited competition in the market and little incentive to hold costs down.

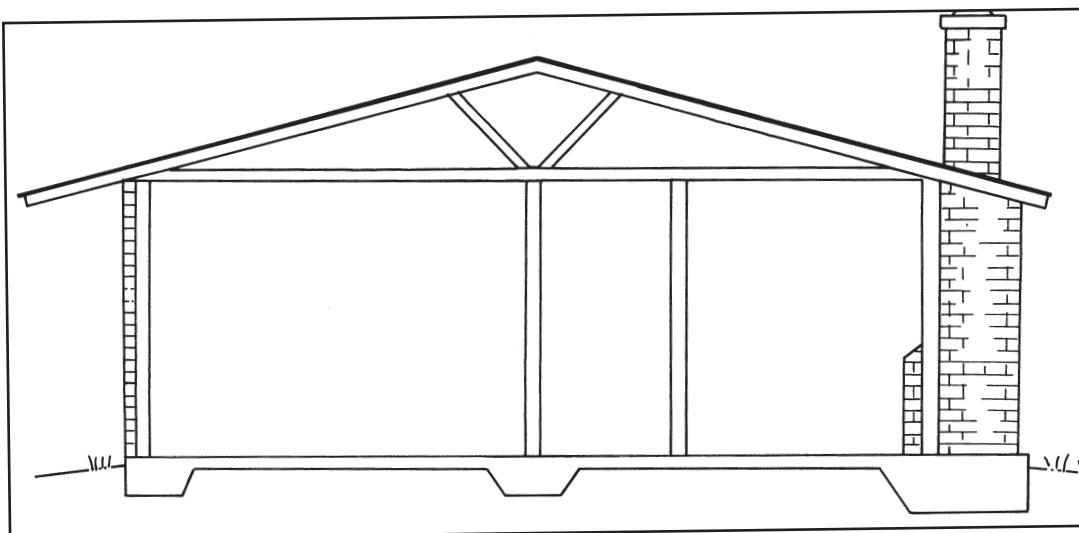
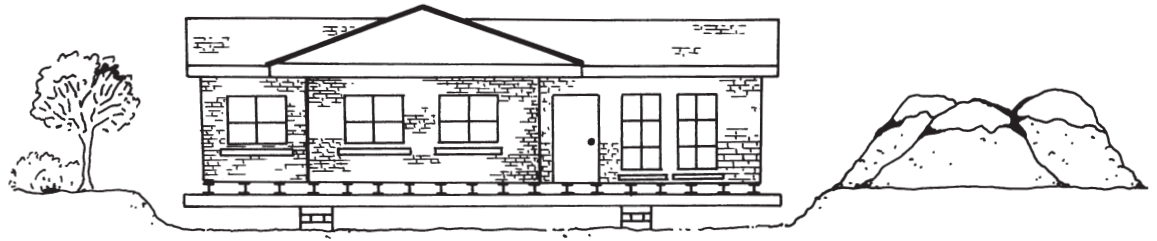


Figure 1. Cross-section of a house built on a slab. Grade beams and footers support load-bearing walls. This slab is also thicker under the fireplace. Brick veneer is attached to the wall, but the weight of the brick is carried by the slab.

Figure 2. 2000 sq. ft. house prepared for elevation. Approximately 6,500 cu. ft. of dirt will be excavated when all the dirt is removed from beneath the structure. Dirt to be re-used must be kept dry (cover with plastic sheeting). There will be a large hole under the structure until the elevation is complete and fill-dirt has been added. The contractor should be prepared to pump water out of the excavated area in the event of rain.



Planning and Contracting

There are a lot of decisions to make as you plan your elevation project. One of the biggest decisions is how high to go. This may have been established in your visit to the permit office (see Are you allowed? p.3). If not, How high is high enough? (p.6) will give you some things to consider in making your decision.

Before giving estimates, a contractor and engineer will need to inspect your building and property, find the load-bearing walls, and locate the utilities and property lines. The contractor will analyze the obstacles in the work area and will need to know if any public utility lines or other underground obstructions cross the property.

Your engineer will document these items in a site plan and foundation drawings to be included in the elevation contract. If the contractor does the engineering, you should hire an engineer to review the contractor's foundation plans and to act as your inspector. Your engineer should have experience with local soils and should design the new foundation with wind and seismic hazards in mind (see Louisiana Floodplains, p.13).

An architect can help you with designing exterior features such as decks and porches to improve the aesthetics of the raised structure. The architect can also tell you if a look you are trying to achieve is practical from a construction standpoint.

The sheet on page 11 may help you organize your plans and estimate the cost and size of your elevation project.

Arrangements that Work

The complete elevation project includes: design and drafting; preliminary site work; the elevation itself; rehabilitating the building with porches, decks and possible roof alterations; repairing driveways; and landscaping.

You may contract the entire job to a single contractor, subcontract portions to different contractors or perform some of the tasks yourself. The elevation contractor should have control of the job from the time digging starts until the house has been set on its new foundation and the steel removed. If the new foundation and supports are to be built by subcontractors, the elevation contractor, not the homeowner, should subcontract that work. This arrangement allows the elevation contractor to assume complete responsibility for the structural integrity of the elevated structure.

Elevation, construction and landscaping contractors will buy materials to be installed on your property. Your contracts should require the contractors to provide proof of payment for materials and releases of lien from suppliers and subcontractors as a condition of payment.

For additional information on working with contractors, refer to AgCenter publication 2171, How to Choose and Hire the Right Contractor.

Information providers:

Permit official - Height limitations, permits, BFE

Utility companies - Location of service lines and mains

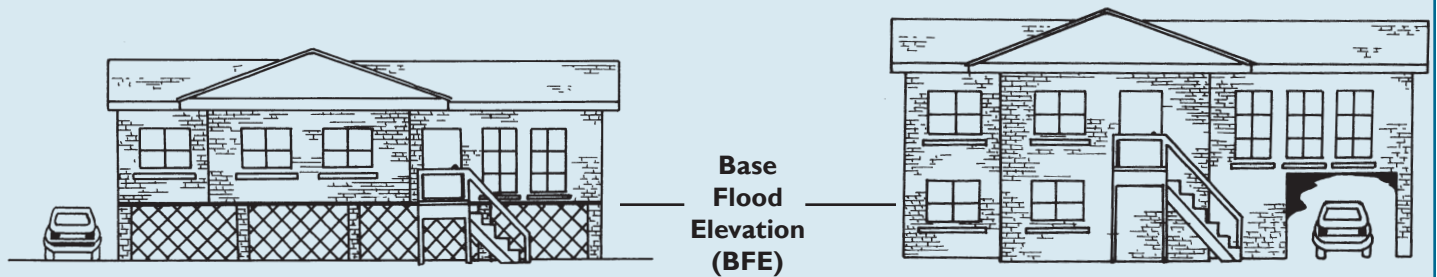
Structural or civil engineer - Site plan and foundation drawings

Architect - Plans for exterior remodeling, decks, etc.

Elevation contractor - Feasibility and pricing information

Building contractors - Plumbing, electrical, masonry, carpentry, pricing information

How High is High Enough?



The 5-foot elevation

- Easier access, shorter staircases
- Slightly lower cost to design and construct the new foundation and supports
- Limited usefulness of under-slab space
- Wheelchair access requires 60-foot ramp, chair lift or porch lift

The final elevation of your home or business may be set by building codes, subdivision covenants or engineering limitations. If you have a range of elevation options, your decision can be based on appearance of the elevated structure, how well a certain elevation will fit into the surrounding development or one of the factors mentioned above.

The 8-foot elevation

- Higher level of flood protection
- Slightly higher cost to design and construct the new foundation and supports
- Useful under-slab space
- Larger reduction in flood insurance costs
- Wheelchair access: elevator or 96-foot ramp

Note: Floodplain regulations prohibit the full enclosure of space below the base flood elevation (BFE) and the conversion of that area to habitable space.

Finding the Money

The cost of elevating a slab using this method, from planning through landscaping, will usually be about half the cost of rebuilding. At the time the Denham Springs project was implemented, no pre-disaster floodproofing funds were available to individuals, but government funding programs were being discussed. Extension offices will be a source of information on any funding options which become available. Since none of the funding programs being considered will cover the complete cost of an elevation project, you'll need to finance at least a portion of the cost.

If you need to borrow money, consider a home improvement loan. Such loans can be made up to 75% of an approved appraiser's projected value of the improved (elevated) home. Home improvement loans secured by the equity of your home usually have lower interest costs than other types of per-

sonal loans or credit cards. Compare the Annual Percentage Rate (APR) and closing costs of any loans you consider.

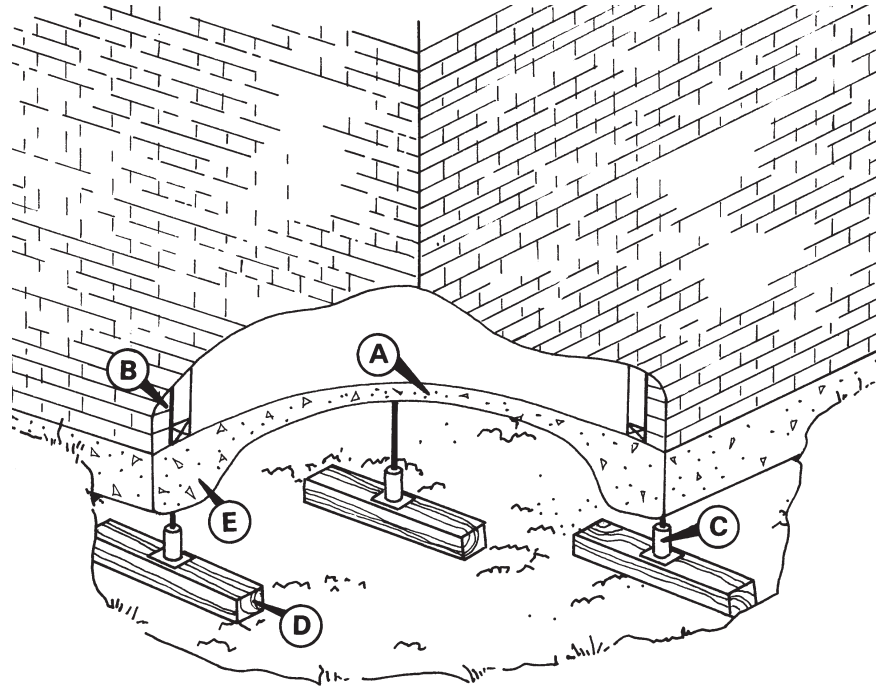
If you have considerable equity in your home and carry a first mortgage loan, you may prefer to refinance the existing mortgage loan into a larger loan. The finance costs (interest, points, etc.) of loans secured by your home may be tax deductible. If the property is securing a Small Business Administration disaster loan, SBA may subrogate its loan in favor of a new first mortgage for flood proofing. SBA also makes substantial elevation loans in special post-disaster situations.

Since the elevation of the slab procedure has been demonstrated successfully on Louisiana homes and floodplains, lenders should be able to justify and make loans for elevation projects but may require documentation such as contractors' plans and specifications and appraisals.

Essence of the Slab Elevation Process

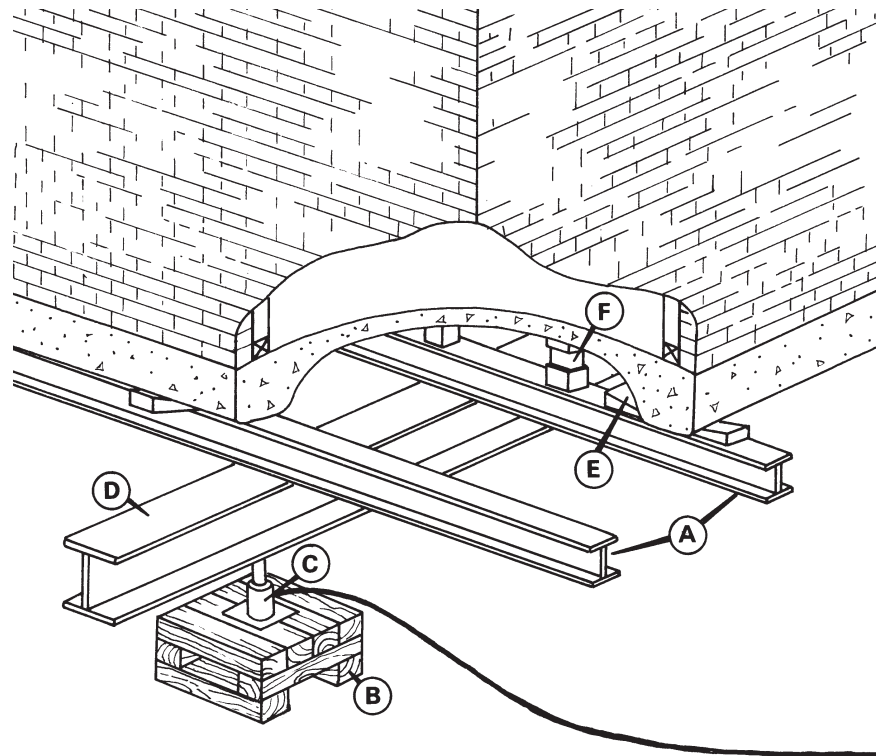
- A. Slab (floor)
- B. Brick veneer
- C. Pin Jack
- D. Crib Piece
- E. Slab footer or grade beam

1. Dirt is removed from beneath the house, leaving the house supported on pin jacks (C). Jacks are placed under grade beams (E) and at 4-5 foot intervals under the entire slab (A). Water and sewer lines under the slab are cut, leaving adequate length for new tie-ins.



- A. Steel beams - spaced 5 ft max.
- B. Cribbing
- C. Hydraulic jack
- D. Lifting beam
- E. Wedge
- F. Shims

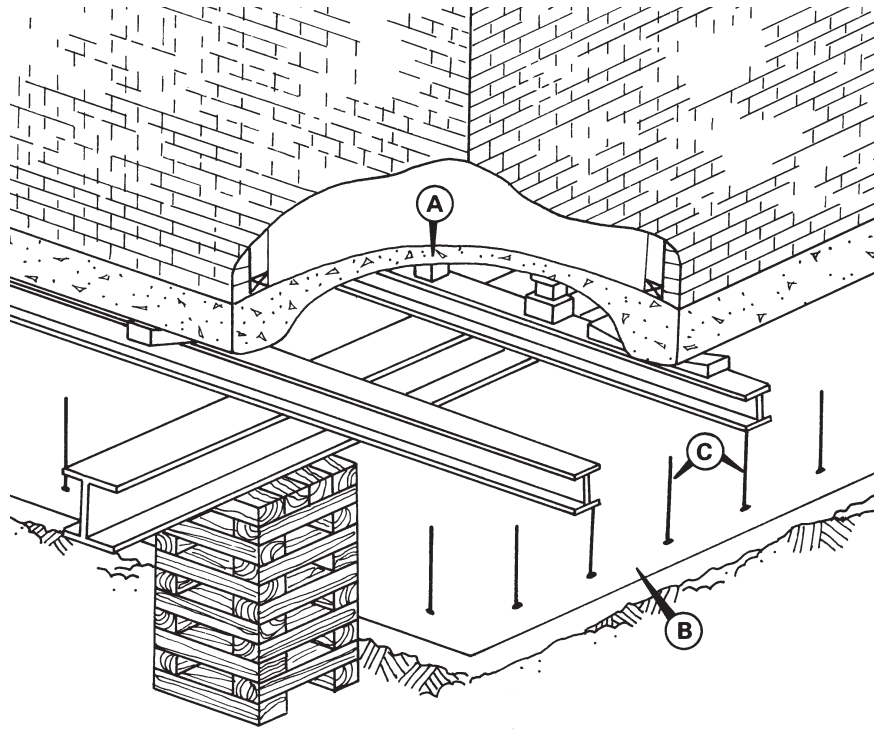
2. When digging is complete, the weight of the house is transferred to steel beams (A). For a typical, rectangular 2100 square foot house, approximately 18 parallel beams and two lifting beams (D) are required. Hydraulic lifting jacks (C) are set at four lifting points, with their bases set on hardwood beams, called cribbing (B).



Essence of the Slab Elevation Process

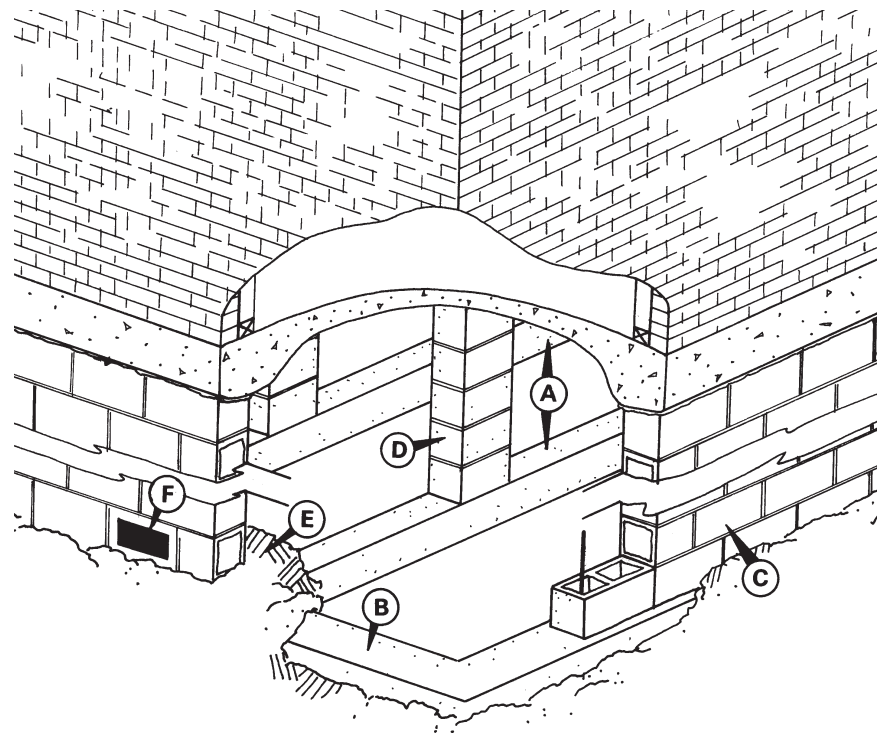
- A. Old slab (floor)
- B. New Slab
- C. Anchor rods

3. Using a unified hydraulic lifting system, elevation can be accomplished in a day. The structure is leveled at its new elevation and sits on cribbing while a new foundation (B) is built (see foundation drawings, page 7). The new-slab foundation design is shown. Anchor rods (C) will secure the new foundation wall to the slab.



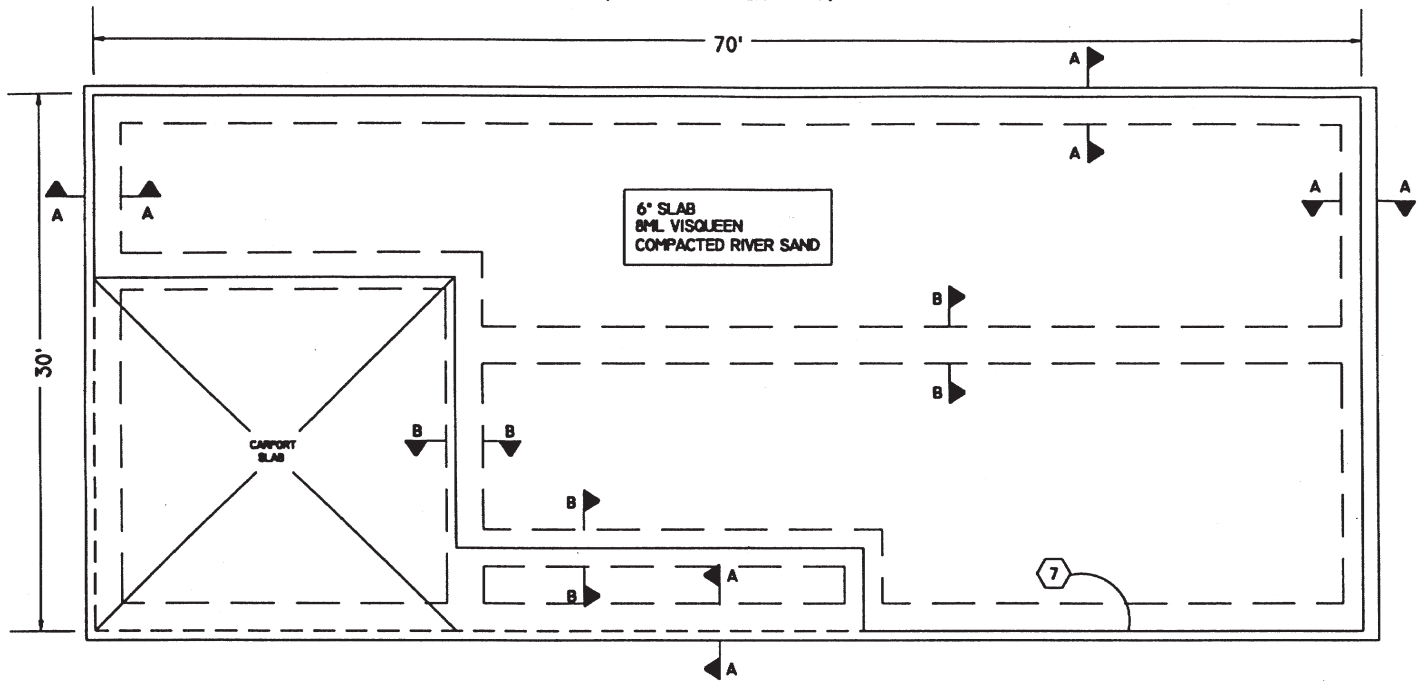
- A. Interior grade beam
- B. Exterior grade beam
- C. Foundation wall
- D. Support column
- E. Grade of fill and lot; min 6" above top of beams
- F. Opening for flood water

4. A foundation wall (C) and columns (D) are built from the new foundation to the old slab, around the steel beams; the joint is packed with grout. The parallel beams and lifting beams are removed, and walls and columns are completed. Openings for floodwater (F) must be no more than 1 ft above grade. The grade-beam foundation design is shown; grade beams (A and B) without a slab must be covered with at least 6 inches of dirt. Special steel beams can be used between columns and/or foundation walls to provide permanent support for the old slab over distances exceeding 5 feet (see drawings, p. 10).

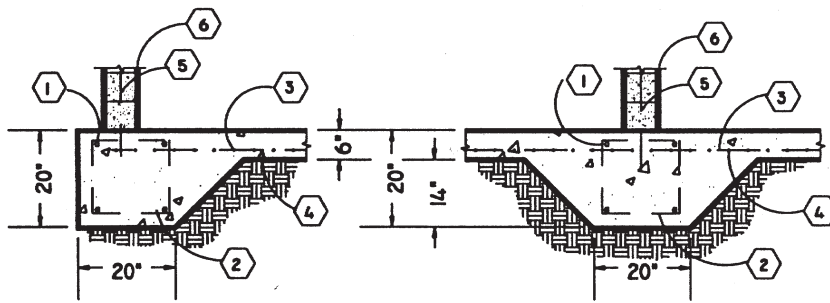


The process is completed by cosmetic finishing of the foundation wall, addition of decks and stairs, repair of driveway and other slabs, and landscaping.

TYPICAL FULL-SLAB NEW FOUNDATION DESIGN
(AND GRADE BEAM ALTERNATIVE)



GRADE BEAM PLAN - SLAB FOUNDATION



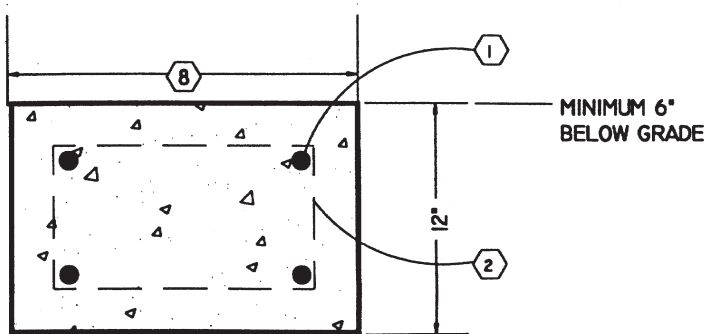
A - TYPICAL EXTERIOR GRADE BEAM B - TYPICAL INTERIOR GRADE BEAM

KEYNOTES

1. 4 - #5 LAP SPLICE 24" MIN.
2. #3 SUPPORT FRAME @ 3' O.C.
3. WWM 6X6 #6 LAP 12"
4. WWM MUST BE CHAIRED @ 4' O.C.E.W. EXTERIOR WALLS.
5. #4 FULL HEIGHT @ 4' O.C. INTERIOR PILASTERS.
#4 FULL HEIGHT EACH CELL
6. 8" CONCRETE BLOCK.
7. EXTERIOR BRICK LINE OF EXISTING RESIDENCE
8. EXTERIOR WALLS - 2'-0"
INTERIOR LOAD BEARING - 16"
INTERIOR NON-LOAD BEARING - 12"

2 GRADE BEAM SECTIONS - SLAB

TYPICAL GRADE BEAM ALTERNATIVE TO FULL SLAB DESIGN



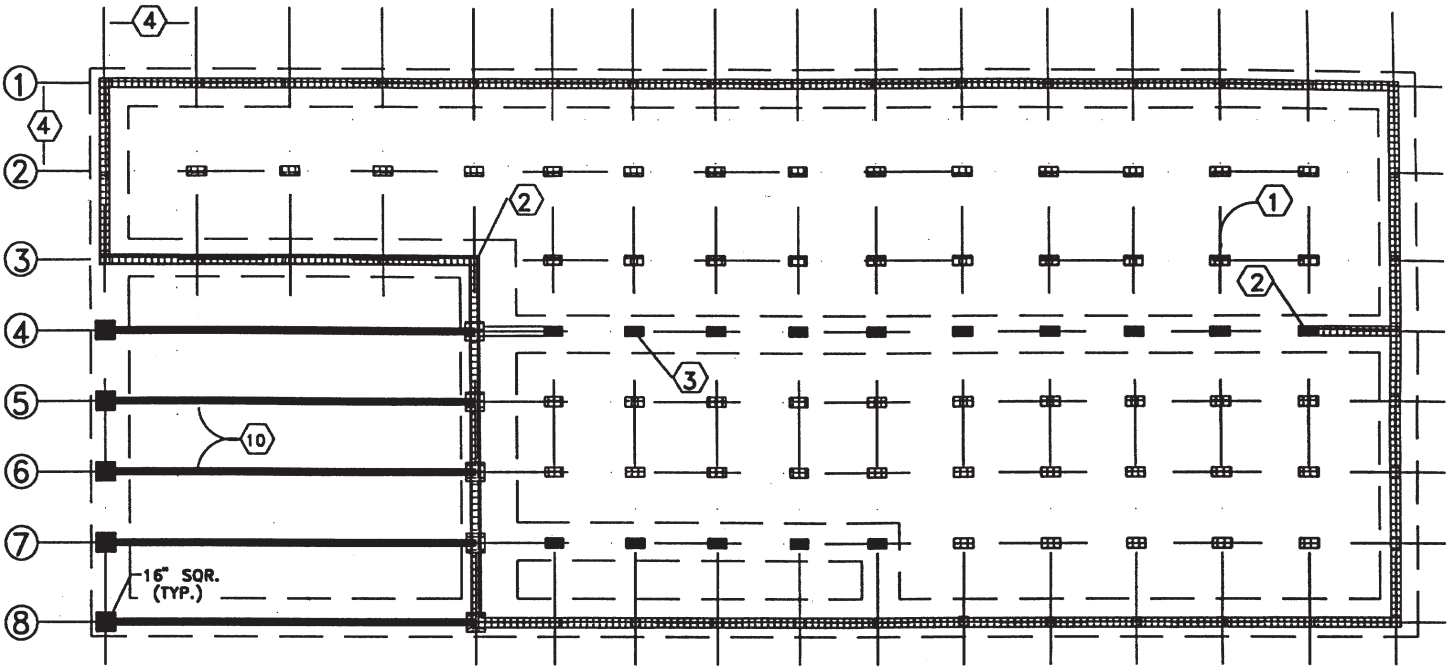
FOR THE NON - SLAB ALTERNATIVE FOUNDATION, GRADE BEAMS ARE POURED IN PARALLEL ROWS (ONE DIRECTION) AND AROUND THE PERIMETER TO SUPPORT THE FOUNDATION WALLS AND BLOCK COLUMNS. INTERIOR GRADE BEAMS WOULD BE POURED AT POSITIONS 2 THROUGH 7 (REF. DRAWING 4). THE GRADE BEAM AT POSITION 4 WOULD BE LOAD BEARING.

3 GRADE BEAM SECTION - NO SLAB

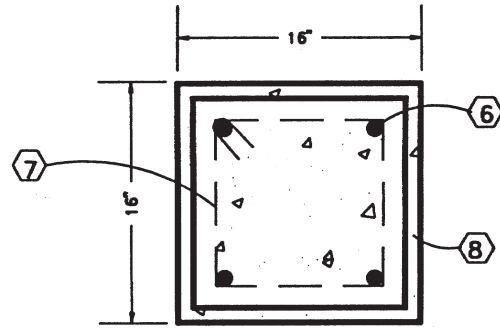
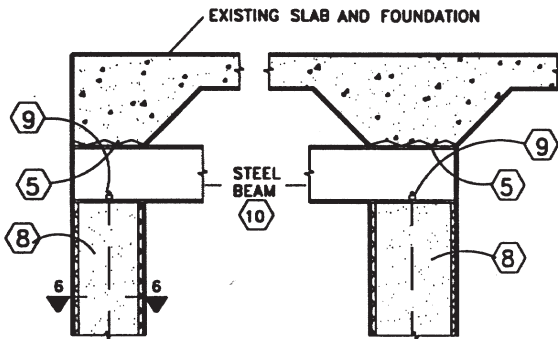
BASED ON INDIVIDUAL DESIGNS PROVIDED BY MCKEE AND DEVILLE, INC.
USE THESE TYPICAL DESIGNS FOR CONCEPTUAL PURPOSES.
INDIVIDUAL STRUCTURES REQUIRE SPECIFIC DESIGNS.

TYPICAL CHAINWALL AND BLOCK COLUMN SUPPORTS

USE OVER SLAB OR GRADE BEAM FOUNDATION



4 CONCRETE BLOCK FOUNDATION WALL PLAN (CARPORT SLAB RAISED)



6 TYPICAL PILASTER

PILASTER ● EXTERIOR / INTERIOR GRADE BEAM

5 PILASTERS @ CARPORT (10 REQUIRED)

KEYNOTES

1. 8X16 BLOCK FILL TOP 8"
2. FILL IN ONE CELL AND REINFORCE WITH 1 - #4 LAP SPLICE 12"
3. FILL TWO CELLS AND REINFORCE WITH 2 - #4 LAP SPLICE 12"
4. 5' MAXIMUM SPACING
5. DRY PACKED GROUT FOR EVEN BEARING
6. 4 - #5 VERTICAL
7. #3 12" SQUARE SUPPORT FRAMES @ 3'O.C.
8. 16" SQUARE PILASTER. FILL WITH GROUT. (SEE DETAIL 6)
9. 2 ANCHOR BOLTS 3/4"X16"
10. STEEL BEAM OVER CARPORT

BASED ON INDIVIDUAL DESIGNS PROVIDED BY McKEE AND DEVILLE, INC.
USE THESE TYPICAL DESIGNS FOR CONCEPTUAL PURPOSES;
INDIVIDUAL STRUCTURES REQUIRE SPECIFIC DESIGNS.

Project Cost Estimating Sheet

This is a cost-consolidation sheet, which you should support with worksheets for several of the items.

| | If an expense is included in a contractor bid on a separate line, check here and leave cost column blank. | Provider/Contractor | Cost |
|---|---|---------------------|------|
| Pre-project planning expenses | | | |
| 1 | Estimating services of a professional engineer | | |
| 2 | Estimating services of an architect | | |
| 3 | Estimating work by an elevation contractor | | |
| 4 | Soil borings/analysis | | |
| Project implementation expenses | | | |
| 5 | Architect's services for project | | |
| 6 | Engineer's services for project | | |
| 7 | General contractor's services, if applicable | | |
| 8 | Insurance (extended homeowner's insurance and cargo) | | |
| 9 | Permits - building/electrical/plumbing/occupancy | | |
| 10 | Inspections (required by local government) | | |
| 11 | Fees to cut off & reinstate utility services | | |
| 12 | Retire & reconnect A/C | | |
| 13 | Security (if property is vacated) | | |
| 14 | Warranty | | |
| 15 | Site preparation (tree removal, salvage of plants, sod) | | |
| 16 | Elevate and set down building - elevation contractor | | |
| 17 | Elevate A/C unit | | |
| 18 | Construct foundation and supports | | |
| 19 | Construct steps/porches/decks | | |
| 20 | Installed cost of elevator (optional) | | |
| 21 | Handicap access (check building code requirements) | | |
| 22 | Construct additional roof area | | |
| 23 | Lengthen service lines | | |
| | Electrical contractor | | |
| | Plumbing contractor | | |
| 24 | Finish exterior of chainwall | | |
| 25 | Insulate under original slab, including plumbing | | |
| 26 | Concrete work not included elsewhere (driveway, etc.) | | |
| 27 | Restore landscaping/site cleanup | | |
| 28 | Lodging for _____ days @ _____ | | |
| 29 | Other | | |
| Total anticipated costs | | | |
| | Contingency allowance (____%) | | |
| Total maximum expenditure, including contingency allowance | | | |

Is this for you?

Elevation is the most reliable method of reducing damage from floods. It works when nobody is home, and it works in flash floods when there's no time to use other measures. When flood levels exceed the protection level, the elevated structure will experience much less damage than a structure protected by wrap, wall, sealant or levee.

Elevation is the only floodproofing technique recognized by the National Flood Insurance Program for reduction of premiums.

Elevation is the only viable, stay-in-place, floodproofing option when anticipated flood levels exceed 3 feet.

If you consider taking the house off its slab, make a cost comparison. Estimate the total cost of that process. Include moving and storing contents, replacing floors and repairing walls. Raising the slab may be less expensive. (This calculation will be different if your home or business is in a damaged condition from flood or fire.)

Elevation, including the new foundation, is usually about half the cost of rebuilding. For the more expensively built and outfitted home or business, the cost will be less than half. It doesn't cost any more to raise walnut paneling than fiberboard.

In comparing slab elevation with rebuilding, you should keep several things in mind. First, if you

rebuild, remember you're not just starting from scratch; you'll need to consider demolition and removal expenses. Second, during construction, you'll have moving and storage expenses and the cost of alternate accommodation. Third, remember you're not simply replacing your home; you're replacing it at a higher elevation.

If physical damage from a flood is compensated by flood insurance, you may find it difficult to justify the cost of elevation on strictly financial terms. But, properties which are a financial burden to the National Flood Insurance Program will find less relief and higher cost in the future as the program strives to remain solvent. Even when flood damages are compensated, flooding is destructive and traumatic.

Slab elevation is for you if you can afford it and if you want to stay in your home or can't sell it. As people become increasingly aware of flooding, a home's flood history and prospects for future flooding make the sale of that property more and more difficult. Elevation may be a way to regain property market value lost because of flooding.

Slab elevation is for you if you have trouble getting over the floods emotionally every time they happen and can't face the physical demands of cleanup and repair any longer. For you, rising above the floods physically, by elevating your home or business, may be your best option.



Louisiana Floodplains

Our dirt makes a difference

Elevating or moving slab-built structures has been practiced for many years in a handful of states. It has been used to remove unwanted buildings from valuable sites, to relocate small businesses to higher traffic areas and to reposition buildings that violate local restrictions. It hasn't been used often as a retrofitting tool for flood-prone homes, and until recently it hasn't been available through Louisiana contractors.

The soils found in Louisiana floodplains make the methods described here difficult to practice in these areas. Natural floodplains have a higher clay content than soils in other parts of the country. When wet, this type of soil is hard to handle and difficult to compact for use in supporting a new foundation. Additionally, even a modest rain will saturate the surface layer of soil on the job site, and the heavy equipment operators will have difficulty driving equipment over it.

During the elevation process, the weight of the structure, slab and steel is supported on a reduced number of ground points. The bearing capacity of the soils in Louisiana floodplains is only 1,000-2,000 pounds per square foot. The bearing capacity is used to determine the number and size of crib bases and temporary support jacks; a low bearing capacity dictates larger and/or more crib bases.

Elevated slabs in other states or in other soil conditions are typically supported on a series of independent columns with 4 sq. ft. foundations. Elevated slab structures in floodplains require stronger foundations. The support columns must be tied together on a system of grade beams or set on a new slab (see foundation drawings, p.9).

In Louisiana, you should:

- Measure the soil-bearing capacity on your property.
- Protect excavated dirt and the job site from rain.
- Plan to purchase some special fill dirt for the new foundation.
- Construct a new foundation that includes a slab or fully integrated grade beams.
- Avoid trying to elevate in the rainy season.
- Be prepared to pump water.

Drainage and water handling measures will add to the cost of the project, but will minimize weather-related construction delays and cost overruns.

Meeting multi-hazard requirements

Depending on the location of the flood-prone structure, it will be necessary to take into consideration one or more of Louisiana's other natural hazards.

In coastal areas and along the banks of rivers and streams, where the velocity and wave action of water may be factors, the foundation and supports must be designed to withstand these hydrodynamic forces. In most of these cases, relocation of the structure will be recommended.

Parishes in northeastern Louisiana are in the fringes of the New Madrid Fault seismic zone. Construction in seismic zones may be regulated to improve resistance to earthquakes.

The southern third of Louisiana is hurricane territory, and any place in the state can be subject to tornadoes. The foundation design of an elevated building must meet the wind-loading specifications set forth in the standard building code as adopted by the local government.

One objective of the Denham Springs elevation demonstration project was to provide local examples of homes retrofitted with this technique. You don't have to rely on photographs from remote projects or wonder if the procedure used in Michigan, Florida, Tennessee and elsewhere will work here in Louisiana.

In South Louisiana, you're no more than two hours away from seeing the results. Comparatively, these homes are larger - up to 3,100 sq. ft. - and more complex than those in the Dry Creek and Tug Fork projects referenced below. Louisiana slab construction is different, and the soil conditions are more difficult. Photographs of elevated homes and additional estimating information are found in two publications of the U.S. Army Corps of Engineers' National Flood Proofing Committee:

A Flood Proofing Success Story along Dry Creek at Goodlettsville, Tennessee, 1993.

Flood Proofing Technology in the Tug Fork Valley, 1994.

The elevation process is fully described in the Committee's 1990 publication:

Raising and Moving the [1800 sq ft] Slab-on-Grade House with Slab Attached.

Thorough discussions of flood-proofing options, with technical and financial information, are found in the Committee's 1993 publication:

Flood Proofing, How to Evaluate Your Options.

FEMA's retrofitting resources include:

Design Manual for Retrofitting Flood-prone Residential Structures, 1986.

Engineering Principles and Practices for Retrofitting, 1995.

This publication is part of a collection of printed and video materials about permanent and temporary methods for preventing flood damage. It can be found on the Web in the "Preventing Flood Damage" section at LSUAgCenter.com/Rebuilding.

Rising Above the Floods and its companion video were developed with support from the Federal Emergency Management Agency through Hazard Mitigation Grant Program funds. It has been revised with support from the U.S. Department of Agriculture's National Institute of Food and Agriculture under special project number 2011-41210-30487.

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