Case Studies

Eight case studies demonstrate how substantially damaged houses were elevated in Miami-Dade County After Hurricane Andrew.

The three techniques described in Chapter 3 were used to elevate the eight substantially damaged houses in the following case studies. Three of the houses were elevated with Technique 1, three with Technique 2, one with a combination of Techniques 1 and 2, and one with Technique 3. In each of these houses, the lowest floor was originally below the BFE.

Technique 1 – Extend the Walls of the House Upward and Raise the Lowest Floor.

Case Study 1

The first case study house (Figures 22–32) has masonry walls and a slab-on-grade foundation. The roof of this house was severely damaged by high winds during Hurricane Andrew, and the interior walls suffered extensive damage from flood waters and rain. The owner decided to raise the lowest floor above the BFE by extending the walls upward, placing sand fill on top of the original slab floor, and pouring a new, elevated concrete slab on top.

Figure 22
The front of the house at the beginning of the project. The interior walls and contents, which were destroyed or severely damaged by flood waters, wind, and rain, have been removed. Sand has been placed on top of the old slab to provide the base for the elevated lowest floor. The concrete blocks that will be used to extend the walls can be seen stored in the foreground.

Figure 23
View from the back of the house. The walls have been extended upward with concrete blocks. The plywood visible at the tops of the walls is used to form cast-in-place concrete bond beams that will strengthen the extended walls. The roof trusses shown in the foreground were salvaged for reinstallation. The owner of this house decided to replace the original roof sheathing and shingles with new materials.

Figure 24
Another view of the extended walls. The vertical cuts in the walls next to the windows are for concrete tiedown columns that will be cast in place to further strengthen the extended walls against wind loads. The owner of this house was able to meet the elevation requirement by raising the floor only a few feet, as indicated by the amount that the walls have been extended.

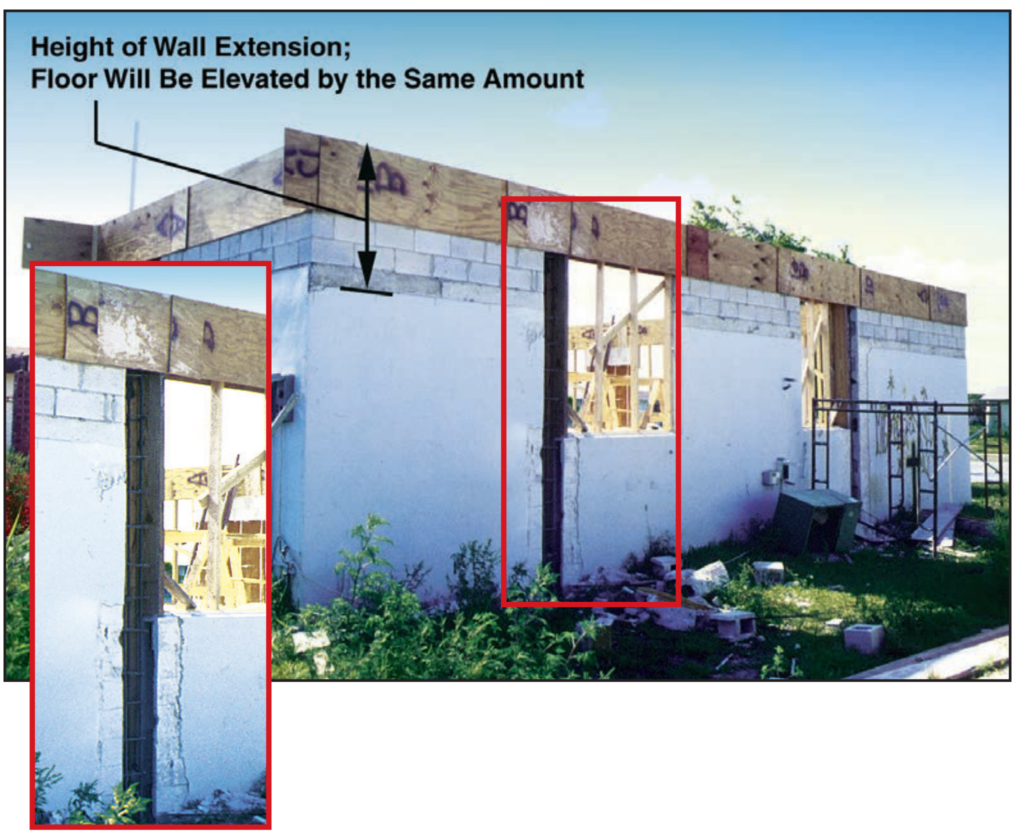

Figure 25
This view through the garage door reveals the different levels of the elevated slab floor, in the background, and the unelevated garage floor.

Figure 26
The roof has been rebuilt with the salvaged trusses, and most of the new concrete slab has been poured on top of the sand fill. The open area in the foreground, where plastic sheeting and wire reinforcement can be seen on top of the sand fill, is where the remaining part of the slab will be poured.

Figure 27
As work progresses, the elevated house begins to take shape.

Figure 28
The bottoms of the original window openings are raised with concrete blocks.

Figure 29
Windows and doors are added. The height of the raised front door shows the amount of elevation.

Figure 30
Interior partition walls and utilities are added.

Figure 31
This view from the rear of the house shows that the project is almost complete.

Figure 32
The final product: an attractive elevated house that meets local floodplain management requirements and is now much less vulnerable to flood damage. In addition, the house is now eligible for a lower rate of flood insurance coverage under the NFIP.

Case Study 2

The second house for which Technique 1 was used (Figures 33–38) is similar to the first, and the modifications made are much the same:

- The roof was removed.
- The walls were extended with masonry block.
- Compacted sand fill was placed over the old slab.
- A new slab was poured on top.
- Concrete bond beams and tie columns were installed.

Therefore, this case study focuses on construction details.

Figure 33
Wood framing for a new concrete staircase that will provide access to the elevated floor.

Figure 34
After the new concrete slab is poured, wood framing for interior walls is added.

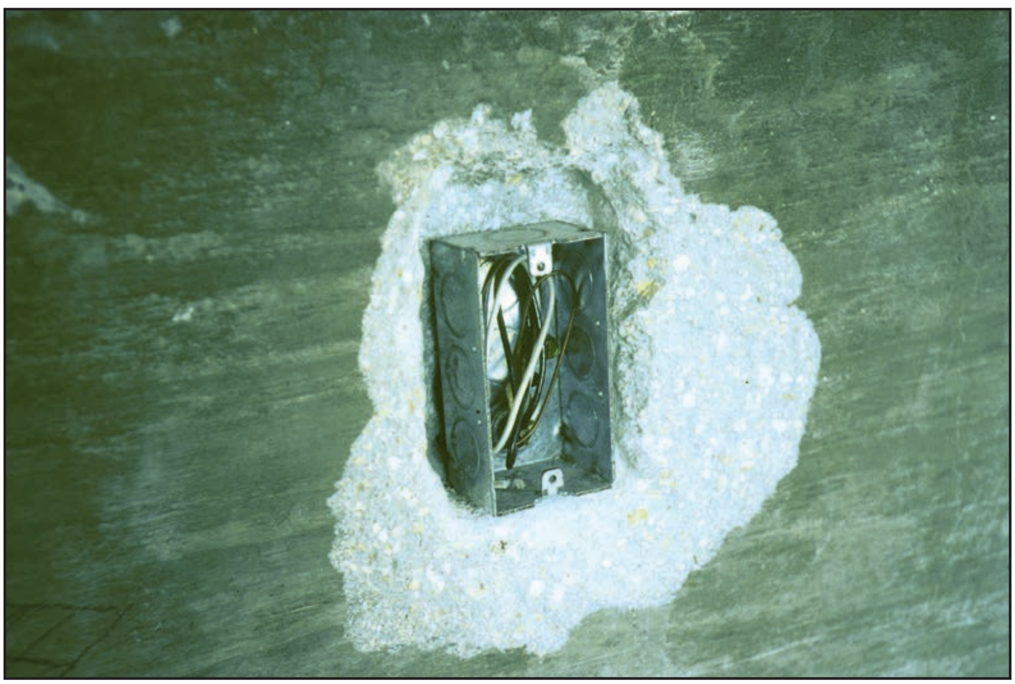

Figure 35
The electrical system is upgraded to meet current code requirements.

Figure 36
In this view from the front of the house, the amount of elevation is shown by the rows of concrete block on the tops of the original walls and by the raised window openings.

Figure 37
The project nears completion. In this house, as in Case Study 1, the level of the garage floor remains unchanged.

Figure 38
The elevated house is now complete.

Case Study 3
In the third house for which Technique 1 was used (Figures 39–44), the lowest floor was raised only about 1 foot. Otherwise, the work performed was essentially the same, with a few minor exceptions.

Figure 39
The roof of this house was removed as a single piece; the trusses were held together with bracing and portions of the original roof sheathing. This approach made it easier to reinstall the roof at the end of the project.

Figure 40
After the roof was removed and the storm-damaged interior gutted, the walls of the house were extended upward and a new bond beam added at the top.

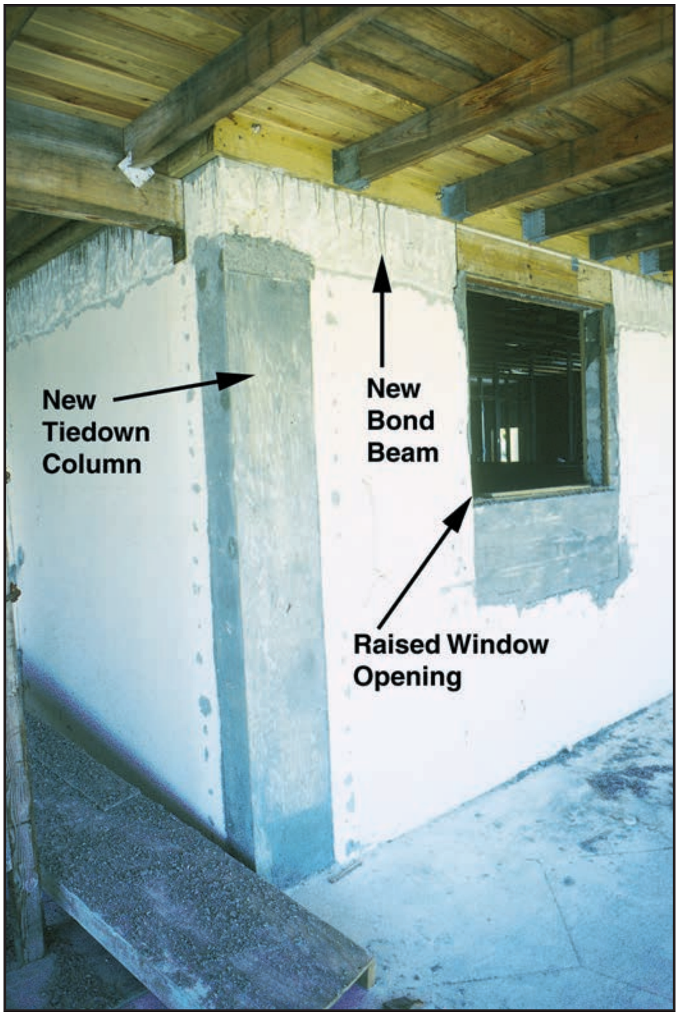

Figure 41
Note the new bond beam at the top of the extended wall, the new concrete tiedown column at the corner, and the raised window opening.

Figure 42
This view from the back of the house shows the height of the elevated slab floor.

Figure 43
The owner of this house decided to use light-gauge metal framing for the new interior walls.

Figure 44
The final product. As in the first two houses, the garage floor remains at the original level. The relatively small amount of elevation required for this house has altered its appearance very little.

Technique 2 – Convert the Existing Lower Area of the House to Non-Habitable Space and Build a New Second Story for Living Space.

Case Study 4
The owner of this house (Figures 45–50) chose to build the new second story with reinforced concrete block.

Figure 45
Concrete bond beams similar to those shown earlier were used in this house, but here they were installed on the tops of both the original first-story walls and the new reinforced concrete block second-story walls.

Figure 46
Concrete tiedown columns, such as the one to the left of the window in this photograph, were also used in this house.

Figure 47
The tiedown columns extend down from the new second-story walls and into the original first-floor walls. The columns tie the first and second stories together and provide a continuous load path that helps the house resist the forces of high winds.

Figure 48
Wood 2 by 4 studs were used to frame the interior walls of the second story.

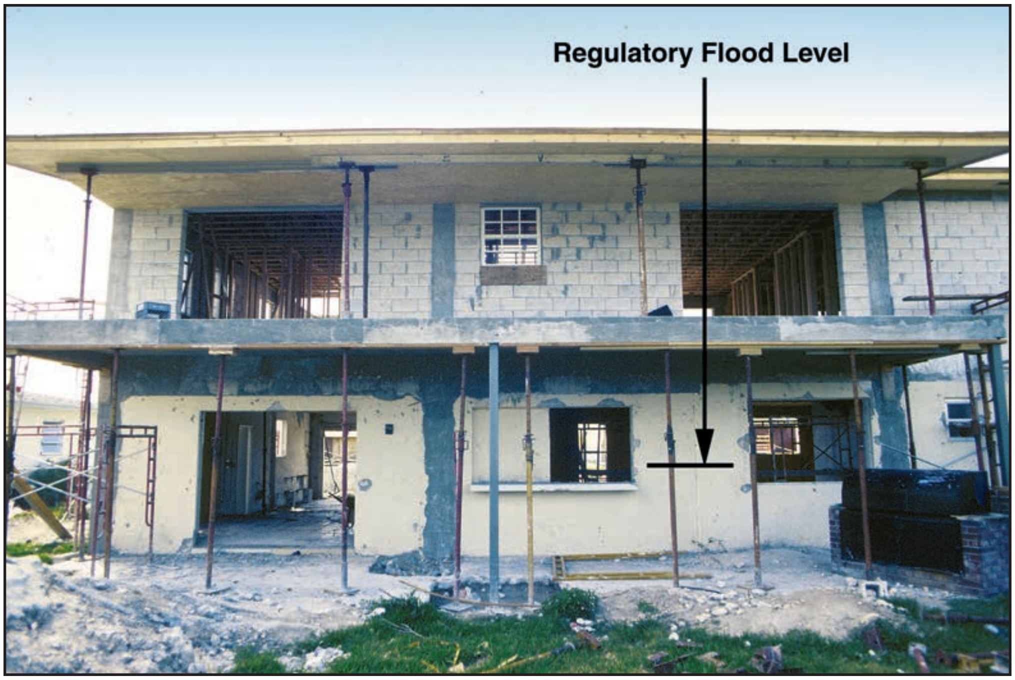

Figure 49
The house nears completion.

Figure 50
Not only does the completed house meet the requirements of local codes and the NFIP regulations, it now includes a substantial amount of parking and storage space below the new living level. In addition, because the lowest floor is now over 4 feet above the regulatory flood elevation, the house is eligible for NFIP flood insurance at a greatly reduced rate of coverage.

Case Study 5
Concrete bond beams and tiedown columns were used in this house (Figures 51–60) as well, but the owner decided to use metal-frame construction rather than concrete block for the new second story.

Figure 51
The storm-damaged first story has been gutted in preparation for construction.

Figure 52
The existing first-story walls have been strengthened by the addition of concrete block. Metal columns and beams have been added to help support the new second story.

Figure 53
As the second story takes shape, its size in relation to the size of the original house becomes apparent.

Figure 54
Metal framing is used for the new second story, including the walls and roof support system.

Figure 55
Metal framing also supports the floor of the new second story.

Figure 56
One advantage of metal framing is its relatively light weight. An additional advantage is that the screws used to attach metal-frame components provide strong connections.

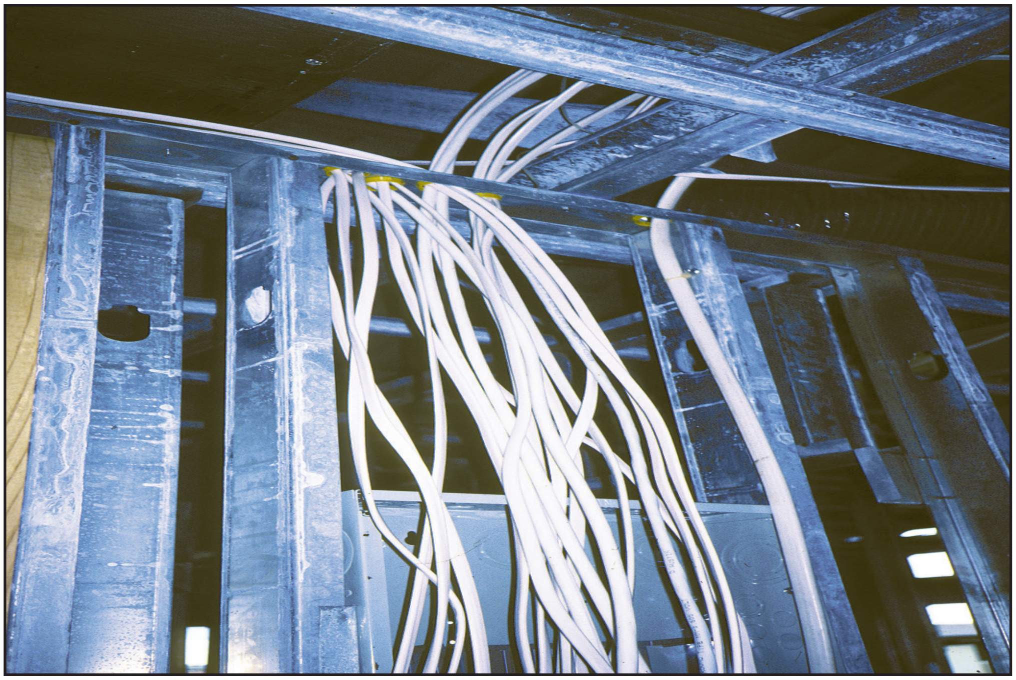

Figure 57
The project progresses with wiring and other utility work. As in each of the other house elevation projects, all current building code requirements must be met.

Figure 58
The new second story nears completion. The roof is made of formed metal panels.

Figure 59
The exterior walls consist of prefabricated concrete panels. Innovative techniques such as those employed in this project are helping homeowners who need practical and economical methods of repairing and protecting their houses.

Figure 60
The completed house has the appearance of a typical two-story residence. As in the house in Case Study 2, the lower floor is used only for parking, storage, and building access; the new second story provides the living space.

Case Study 6
The third house for which Technique 2 was used (Figures 61–64) differs from the first two in that the owner decided to build a wood-frame second story.

Figure 61
The wood-frame second story takes shape.

Figure 62
After the wood framing was completed, the roof and exterior wall sheathing were added.

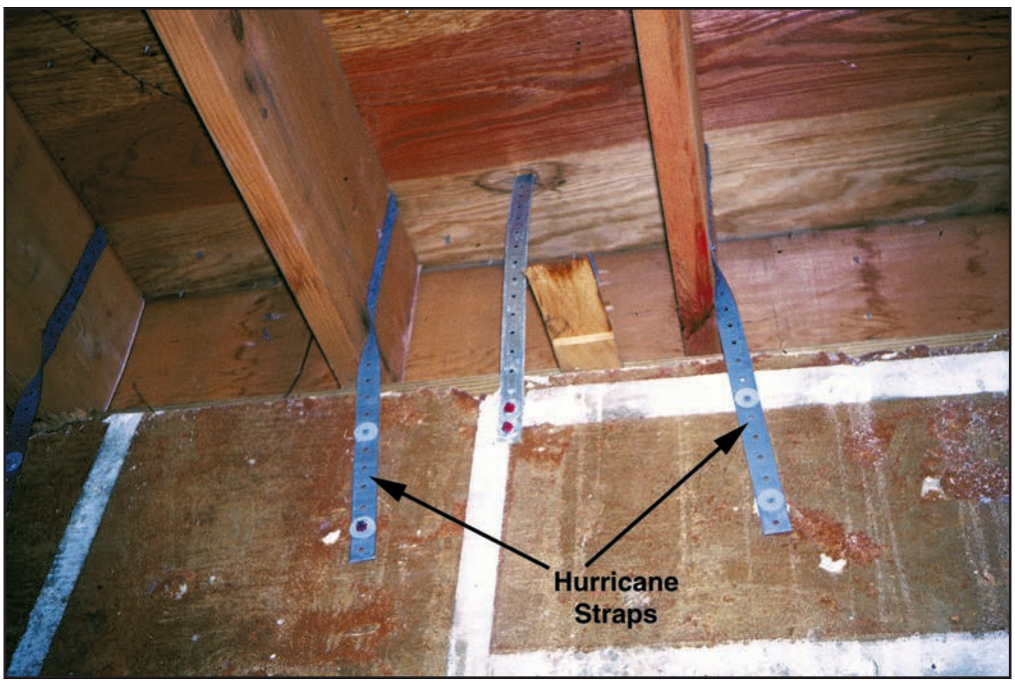

Figure 63
The new second-story walls are securely connected to the original first-floor walls with galvanized metal hurricane straps.

Figure 64
From the outside, the completed house, with its stucco walls, looks like a conventional masonry house.

Combination of Techniques 1 and 2

Case Study 7

Many owners of substantially damaged houses in the areas affected by Hurricane Andrew took advantage of the opportunities afforded by their elevation projects to make additional improvements. For example, the owner of the next house (Figures 65–72) used a combination of Techniques 1 and 2. In addition to extending the walls of the house upward and raising the lowest floor above the BFE, he built a new second-story addition over the garage. The addition was not a necessary part of the elevation process, but it does provide additional living space well above the flood level.

Figure 65

After the house was gutted, the walls were extended upward with reinforced concrete block. In this view from behind the house, the rear wall of the new second story can be seen on the left and the extended first-story wall on the right. Note the new raised window opening in the extended wall, just above the original opening.

Figure 66
The new second-story walls as seen from inside the garage.

Figure 67
The extended first-story walls.

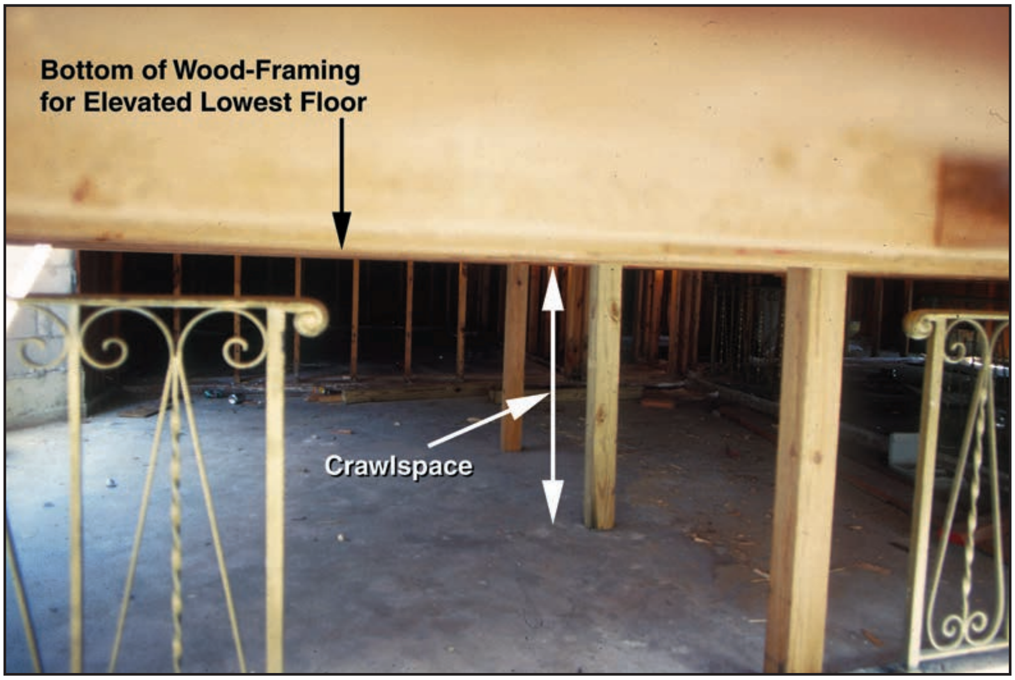

Figure 68
Rather than install a new concrete slab on compacted fill, the owner of this house chose to build a new wood-frame floor above the old concrete slab. This method creates a crawlspace below the new floor.

Figure 69
Wood framing is used for the new second story.

Figure 70
Metal hurricane straps are used to tie the structural members together and create a continuous load path from the roof to the foundation.

Figure 71
All plumbing and electrical renovation work must be performed according to state and local code requirements.

Figure 72
The completed house is compliant with local floodplain management requirements, is more resistant to flood damage, and provides additional living area above the flood level.

Technique 3 – Lift the Entire House, With the Floor Slab Attached, and Build a New Foundation To Elevate the House.

Case Study 8
Unlike Techniques 1 and 2, which build up from the existing foundation and walls, Technique 3 lifts the entire house with hydraulic jacks and builds a new foundation below it (Figures 73–85).

Figure 73
Like the houses shown previously, this one-story house, with its concrete block walls, concrete slab foundation, and attached garage, is typical of the houses in the area affected by Hurricane Andrew.

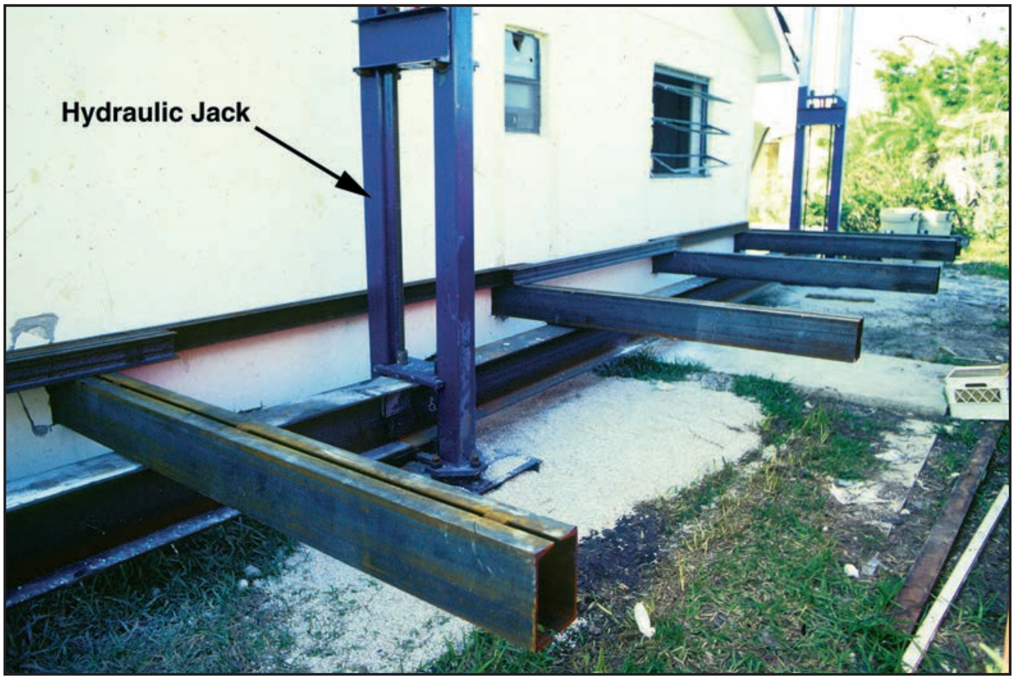

Figure 74
In this variation of Technique 3, steel beams are inserted through the walls of the house rather than under the slab. The beams span the length and width of the house and cross one another inside to create a grid. Outside the house, the beams rest on larger beams that will be raised with hydraulic jacks.

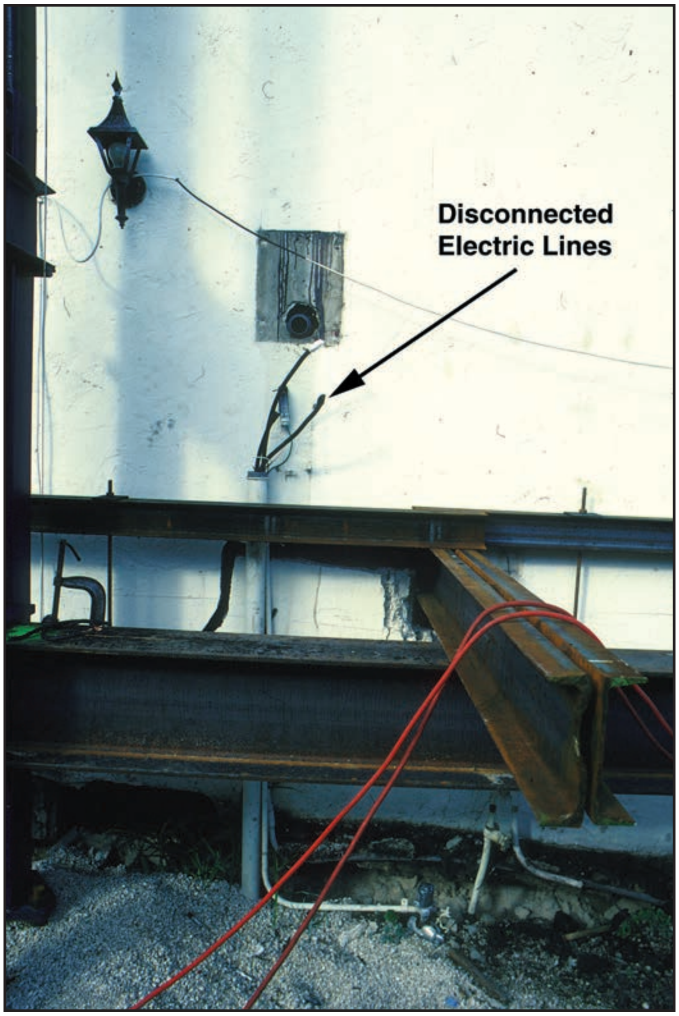

Figure 75
Electrical lines and other utilities were disconnected early in the project.

Figure 76
Inside the house, workers drill holes in the concrete slab ...

Figure 77
... install anchors ...

Figure 78
... and use hangers to attach the anchors to the grid of steel beams.

Figure 79
The anchors and hangers connect the slab securely to the beams, enabling the beams to raise the slab along with the rest of the house.

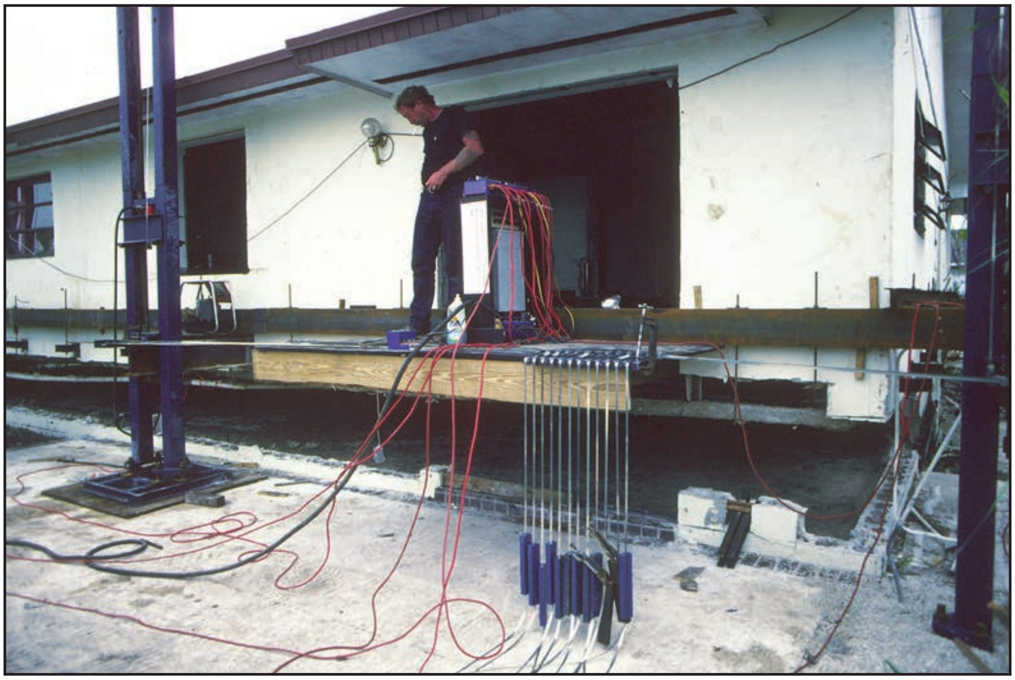

Figure 80
Lifting the house, while simple in theory, is complicated by the need to ensure an equal amount of lift at each jack throughout the process. Too much or too little lift at even one jack can cause the slab and walls to crack. The elevation contractor for this project used a sophisticated jacking system that provided the required level of control.

Figure 81
The house and slab were raised one full story.

Figure 82
While the jacks and beams supported the house, new steel foundation members were installed below.

Figure 83
Concrete blocks were brought to the site ...

Figure 84
... and used to build the lower-level walls.

Figure 85
The completed house, with lower-level space for parking and storage and upper-level living space, looks as if it were originally designed and built as a two-story structure.