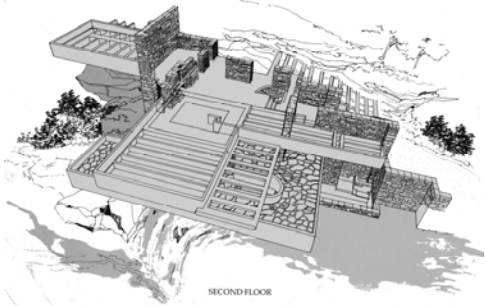


BACKGROUND ON FALLINGWATER'S STRUCTURE

The cantilever is the basis for Fallingwater's structure. Three horizontal trays made of reinforced concrete form the three levels of the house, echoing the natural rock ledges beneath the house that jut out over Bear Run. Think of a diving board. The board extends out into space with no vertical support underneath its free end. At the pool's edge it rests on a support, or fulcrum, and it is anchored, or counterbalanced, so that when you stand on its free end, it does not fall into the water. Compare this to Fallingwater, where four piers, or bolsters anchored into a boulder underneath the main floor act as the fulcrum for the house. Counterbalancing weight to the back, or north side, of the house keep it from toppling into the stream.



Fallingwater is not the first house Wright designed using cantilevers. From his prairie houses onward, he strove to destroy the boxiness of rooms and houses: in opening up new vistas to their inhabitants and eliminating obstructions, he created an atmosphere of freedom and repose.

On a small scale, wood construction can accomplish this; but for the daringly large cantilevers at Fallingwater, Wright needed a material that could both span great distances and be strong enough to carry the weight. Wright chose reinforced concrete (here reinforced with interwoven rods, not beams).

Throughout his career, Wright advocated the use of modern technology to create new spaces that enhance a natural way of life; in essence, re-connecting people with the natural world by using modern materials and methods.

The Cantilevered Reinforced-Concrete Trays

The great sharp-edged rock ledges exposed at the waterfalls suggested to Wright the possibility of similarly extended, boldly proportioned horizontal floor units, cantilevered out in space like the rocks themselves. These trays could be built of reinforced concrete, uniting the supple strength of steel rods with the massive solidity of poured concrete. This technique had begun to be mastered late in the 19th century and Wright had understood its possibilities with unusual insight. Cantilevering can give shelter without interrupting the space that people see or traverse. Cantilevers define without obstructing - a new liberty for architecture.

Reinforced concrete is concrete poured around slender steel framework (which can be given various shapes). When the concrete sets, the two materials work together to resist stress and strain; they form a strong fire resistant whole. Correctly united, the materials will not separate in use.

In Fallingwater, Wright designed these trays as double shelves with upturned edges that give added rigidity. Within this tray, the usable floors rest on thin partitions rising out of the lower structural slabs. Where one tray acts as ceiling to another, the double shell may be hollowed upward. If the ceiling is merely a single slab, it is sometimes stepped down, varying the ceiling

surfaces and room heights. This structural folding of the reinforced concrete slabs adds rigidity.

Almost all of these concrete slabs, floors or roofs, are cantilevered daringly, establishing the open interior spaces of Fallingwater that seem to reach out and join the space of the valley outside. Every so often the concrete slabs are anchored into the living rock of the site.

The Structural Repair

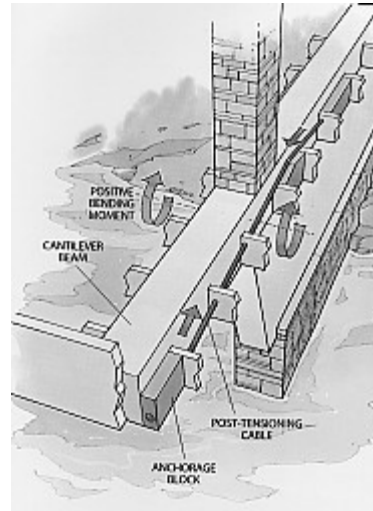
For years, the Kaufmanns, and later the Western Pennsylvania Conservancy, attempted to patch the cracks on the master terrace parapets that opened up at the time of construction. The cracks always reopened.

In preparation for repainting the house in the mid 1990s, the WPC commissioned an analysis of the master terrace to seek a solution for the cracking. This analysis and two subsequent studies showed that the master terrace transfers its load to the main level via steel window mullions at the south of the living room. The studies also showed that the main level was insufficiently reinforced with steel to carry its own load as well as the load of the master terrace above.

Measurements taken at the time showed that the main cantilever (as well as the second level above it) had deflected up to 7", and was still deflecting. Temporary shoring was installed in 1997 to support the deflecting cantilever while a solution for this major structural problem was found.

In 2002, crews removed the living room floor and installed external post-tensioning cables to some of the main level beams and joists beneath it. The cables were attached to the sides of the

original beams and joists, and tensioned to add compressive strength to the building. The post-tensioning caused the building to lift up to ½ inch, closing the historic cracks. The building is now self-supporting again. The living room floor was then reinstalled, and today the repair cannot be seen.



The Vertical Core

Selecting a large boulder indicated on the contour map, Wright established on and around it a bold vertical wall



structure that, inside and out, acts as the core of Fallingwater. For many years Wright had designed the majority of his houses around central cores that included fireplaces. Here the core includes the hearth and chimney and is the highest element of the main house.

The core sets the style for stonework throughout the house. Flat stone slabs, quarried just up the hill from the house, are laid up in irregular horizontal layers that resemble rock outcroppings typical of the surrounding terrain. The wall is

wrapped around the 3 vertically stacked rooms, gaining strength from this form. It carries not only chimney flues from each floor, but also many pipes and ducts that serve the upper rooms and hallways.

The Masonry Supports

The great stone chimney core also stabilizes the cantilevered trays. Other stone walls throughout the house act somewhat differently. They do not extend down through the slabs to the earth, but act as spacers between slabs, transferring weight and bracing the slabs against twisting.

It is the concrete trays that are the principal structure elements, extending through the vertical stone walls nearly everywhere. In this way, Frank Lloyd Wright emphasized the image of a house composed chiefly of horizontal trays echoing the bold rock ledges below, establishing a unity of scale and form - architecture and nature correspond.

The Glass Screens

The spaces of Fallingwater, ingeniously varied, arranged, and illuminated, require protection from the weather. The back, facing a cliff, is shielded mostly by stone and, around the bathrooms, by regular wood stud and plaster walls. Everywhere else, Wright



used clear plate glass elegantly framed in thin metal frames or occasionally set directly into the masonry of the building. The thin metal frames and the mitered, sealed corner windows, provide a delicate veil between enclosed

and open spaces. Thanks to their elegant design, these are perceived as a continuously extending element.

Building Fallingwater was a complicated and detailed operation, yet the resulting house seems to belong quietly in its setting. It fits into the hillside and extends out over the falls as if it has always belonged there. Within it, the areas for social life, privacy, and service are clearly separated but conveniently linked. Frank Lloyd Wright's masterpiece continues to unite human life, architectural form, and nature.

Concrete, steel, stone, and glass

The materials chosen for Fallingwater are used honestly and reflect the rustic character of the site. The stone, native Pottsville sandstone, was quarried on the site and laid in a rough, shifting manner to imitate the natural stone layering (compare it to the rock ledge jutting out over Bear Run upstream from the house). It merges the house with its site, making it appear to grow from the natural boulders at the waterfall.

In contrast to the rough stonework, the concrete surfaces appear soft and warm. Although reinforced concrete is not usually considered a natural material, its ochre color matches the sere of the back of a fallen rhododendron leaf. In addition, the rounding of the concrete edges on the parapets speaks of the plasticity, or ability to be molded, of concrete in its fluid state.

Steel is essential to the strength of the concrete, almost forming a skeleton that becomes visible throughout the house in railings, shelving, and window framework. Wright chose the "Cherokee red" color of a Native American pot for the metal surfaces. The color reminds

one of fire and the very core of the earth, the origins of metal.

Clear glass is used as a wall surface (instead of a hole in a wall), and is not covered, thus permitting the outside to flow freely into the interior of the house. At certain times of day, the glass surfaces become very reflective when seen from the outside, and echo the mirror-like surfaces of a calm pool of water. At night, the glass seems to disappear.

