FRANK LLOYD WRIGHT'S GUGGENHEIM MUSEUM

He adds new dimensions to the use of poured concrete in building construction

BY GEORGE N. COHEN*

On Fifth Avenue, between 88th and 89th Streets in New York City, one of the most unusual concrete buildings ever constructed—the Solomon R. Guggenheim Museum — is nearing completion.

Featuring a spiral ramp making six turns at an approximate grade of 3 percent, stiffened by exterior webs at 30-degree intervals, and an inner court covered by a glass dome, this structure represents the great architect's conception of a natural facility for viewing modern art in a modern setting.

Reinforced concrete was used throughout, with lightweight "Lelite" aggregate for the superstructure. All concrete was designed for 3,500 psi and a plasticizing admixture was used throughout the project. Slump was kept at 3 to 4 inches. Expansion joints were carefully omitted. Control of concrete for uniform strength, the inherent shape of the structure, the arrangement of reinforcing, and the planned extent and location of pour sections, all contributed to the elimination of cracking, a quality so essential for architectural concrete.

The entire project actually incorporates three types of concrete. Lightweight expanded-shale concrete is used in the ramp and floors, while stone concrete (also of 3,500 psi strength) has been used for the interior walls to assure a smooth finish. The outer walls were formed by spraying 5 inches of concrete against curved plywood forms, this work being handled from the inside of the structure.

The foundation presented no unusual problems. Soft rock was conveniently encountered at levels not too far below the basement, and footings were carried to it. Old foundations were encountered and removed. These were massive masonry walls and piers deeply imbedded in virgin soil by the old master builders of the past century, who either had little conception of the strength of their materials, or were blissfully unconcerned with costs.

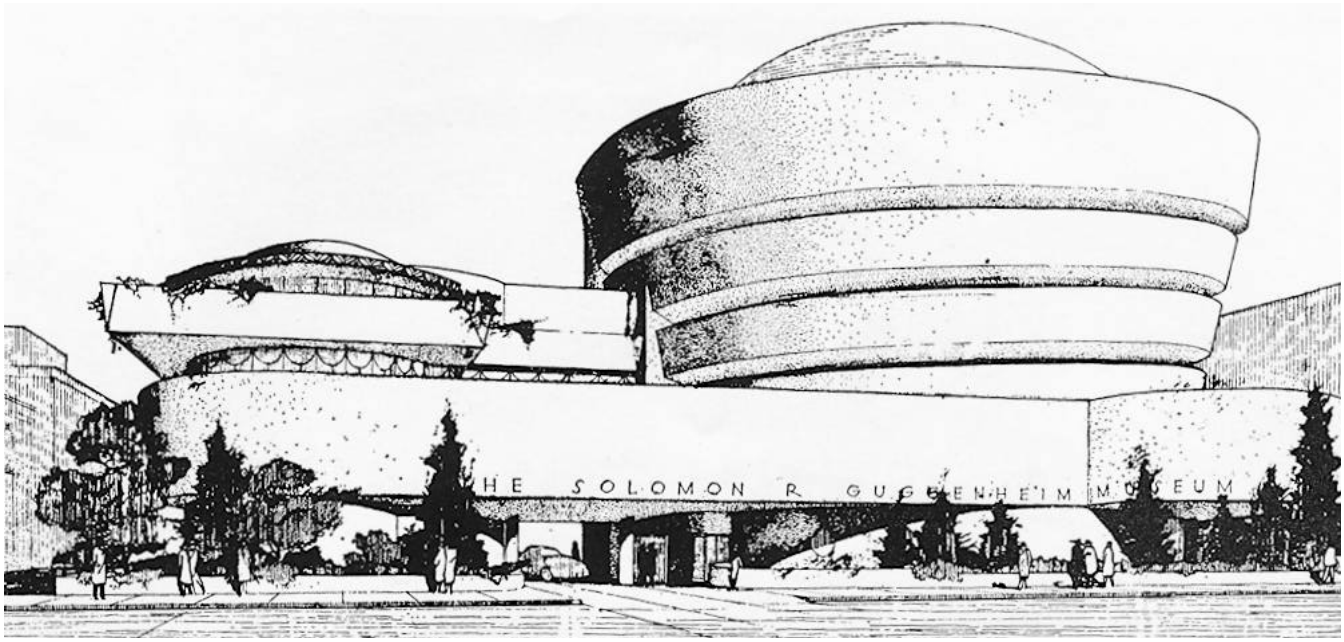
In view of the fact that the concrete structure was mostly exposed, both exterior and interior, and also in view of the fact that the shapes of the component parts were so unusual, great care had to be exercised in the design and erection of the formwork. Detailed dimensional drawings were prepared and used extensively. Isometrics and large scale templates were made to elaborate and translate the intent of the architecture. Depending upon the radii and the shapes, varying thickness and types of plywood, prestwood and metal molds were used. Great care had to be taken in order to provide accurate and uniformly true lines, arises, and surfaces. An intricate mold in concrete is accentuated by good workmanship—and this was the premise throughout.

The structural design features rigid slabs with spans up to 60 feet and cantilevers up to 25 feet, some with highly concentrated end loading. The main ramp cantilevers 14 feet 6 inches to the inner court from a 13-inch deep rigid exterior beam of varying widths. Since the greater widths occur at the higher levels, the overall width of the ramp increases as it spirals upward.

In our cover photograph Architect Frank Lloyd Wright and the author of our article are seen inspecting one of the four-foot diameter reinforced concrete columns in the Solomon R. Guggenheim Museum.

The inside edge of the spiral ramp, which carries a 3-foot high plaster parapet, turns on a smaller and smaller radius as it rises upward. Similarly the outside edge which carries the gunite curtain wall turns on a greater and greater radius as it rises upward. The relationship between these constantly changing radii and the gradually rising plane of the ramp is so arranged that at any point in the height of the structure a horizontal plane will always intersect a true circle. This is the result of a basic pattern of shapes. It is a conception of a large cone (whose apex is theoretically some 180 feet below datum zero) into which is fitted an inverted smaller cone whose apex is theoretically some 270 feet above datum zero.

To lay out this complex structure

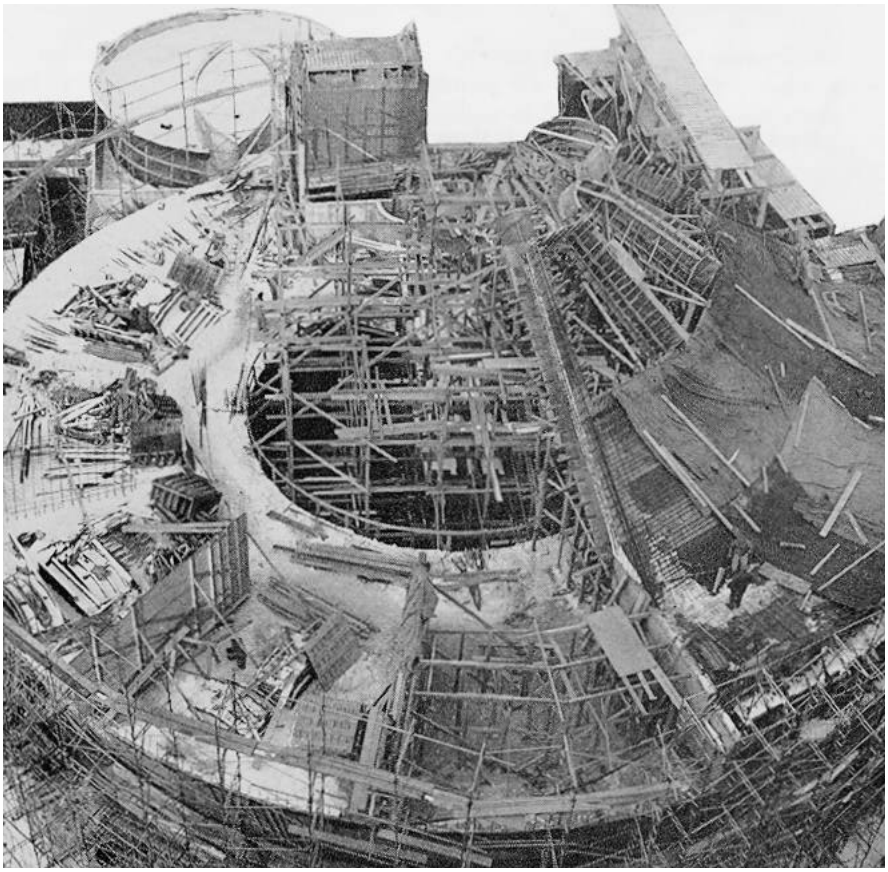


The Solomon R. Guggenheim Museum as it will look when completed late this year. As nearly all-concrete as building construction can be, it abounds in some of the most daring and intricate poured-in-place cast concrete work ever attempted in this country.

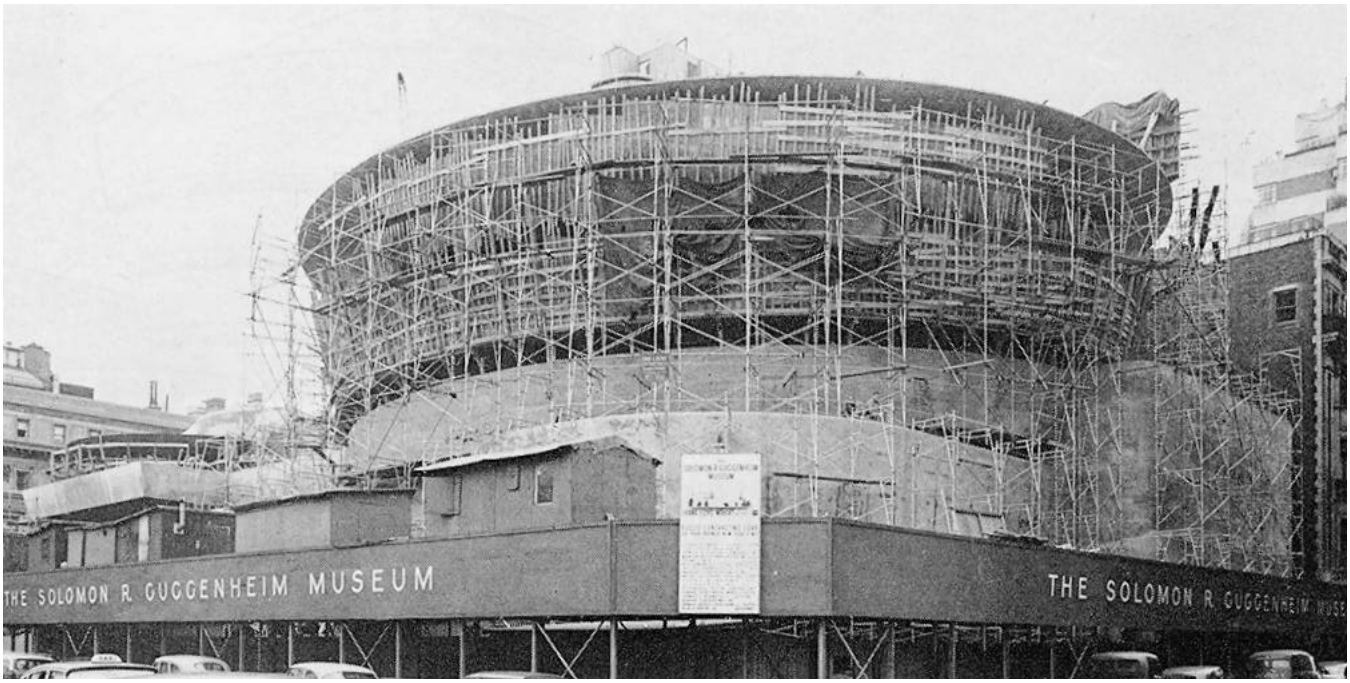
would ordinarily be extremely difficult, but the work was simplified by an overall grid system of 8-foot units. All lines, radial points and axes tied into this grid system in a precise pattern which gave the component parts of the structure an orderly natural scheme. All working points were tied by coordinates into the grid system, and for checking purposes the center point of the structure was physically carried up as the job progressed. The shop drawings and layout plans were accordingly superimposed upon this grid system.

Intricate and beautifully formed concrete members, becoming planting areas, fountains, utility cores, pipe spaces, oversize circular columns, arches and cantilevered balconies, blend smoothly into the whole structure as though they truly belong to it, which they do. Such is the genius of the great architect whose design is so clearly and naturally portrayed.

The outer walls generally consist of 5 inches of gunite shot from the inside against a carefully erected plywood form bent to the shape re-

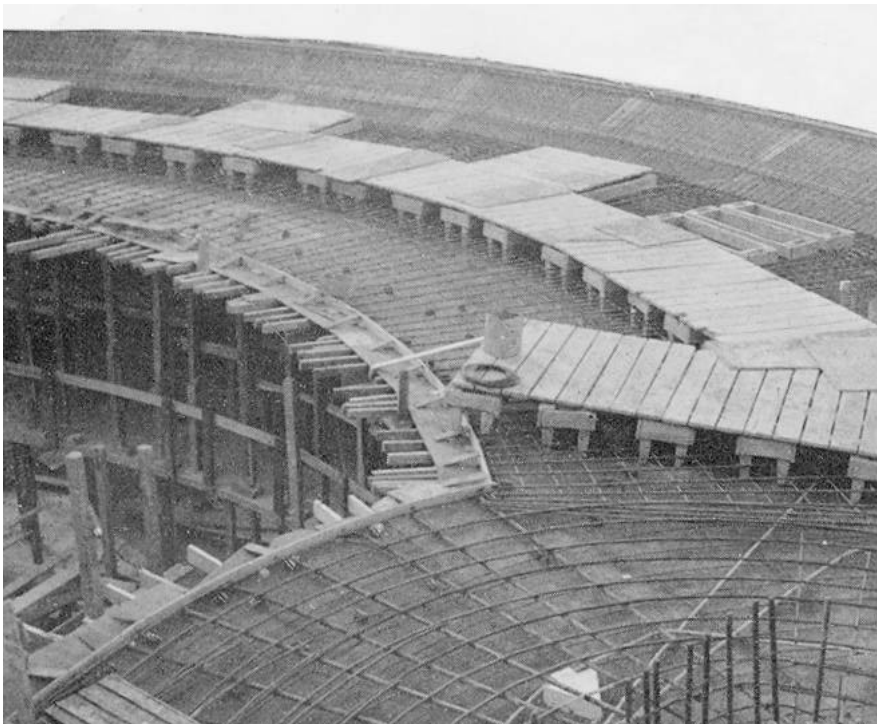


This photograph, taken from an upper story of an adjoining building, shows one of the upper levels of the ramp in the Museum wing in the foreground, and in the background at the left the roof of the 4-story circular administration wing.



This view from street level shows the maze of scaffolding enclosing the circular Museum wing. The ramp makes six turns in all as it spirals up from the main floor to the top level.

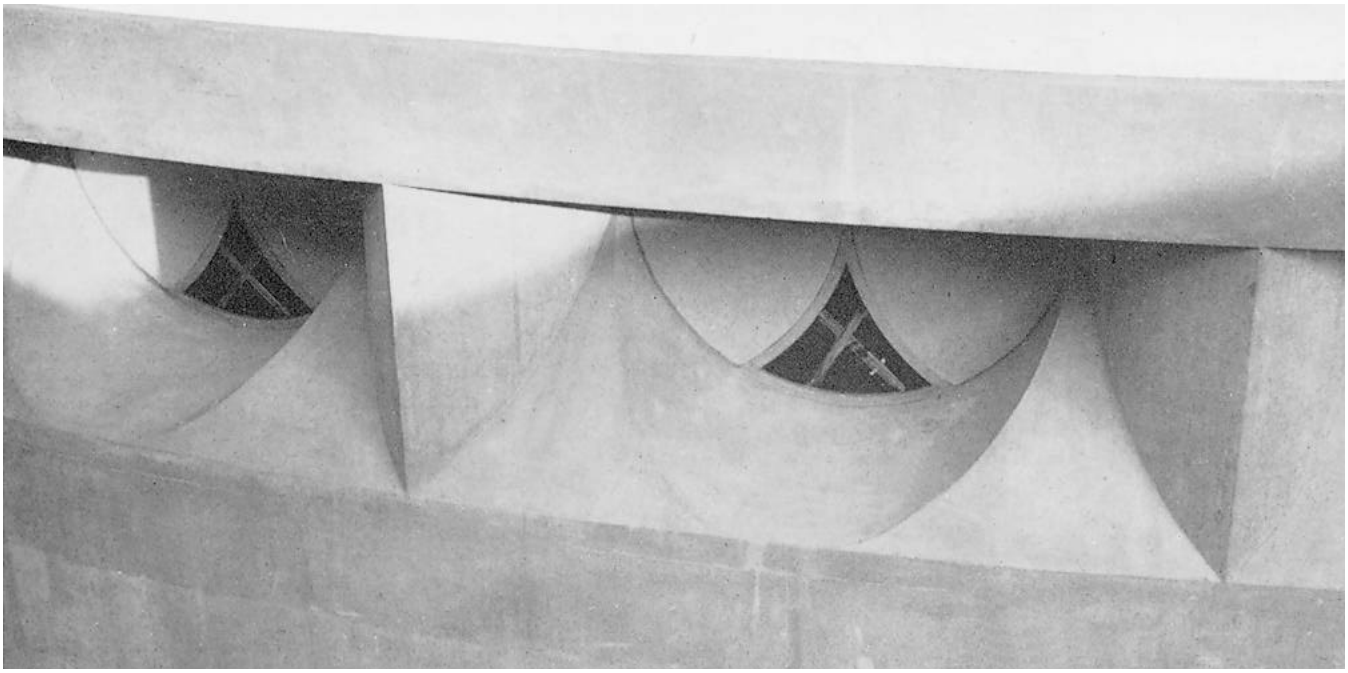
Here a portion of the ramp is shown with the reinforcing steel in place ready for pouring operations to begin. The structural slab of the ramp tapers in thickness from 13½ inches to 4½ inches. It is topped with a 2-inch terrazzo finish.



quired —both circular and sloping. These gunite walls are rigidly connected to the ramp slab and web. They are reinforced with 2 layers of 2 by 2 mesh, plus 2 layers of No. 3 bars at 12-inch centers horizontally, plus 2 layers of No. 4 bars vertically, plus top and bottom continuous No. 4 bars—all secured to a framework of 1 1/2-inch tees which are in turn tied into the structure. The inside surfaces of these walls are furred, lathed and plastered. The outside surfaces are smoothed after the forms are removed, but while the gunite is still green.

The fascia of one of the roof parapets had been designed in sheet copper stamped to a geometric pattern. Due to the difficulty of stamping and erection, these sections were precast in concrete to the required pattern in faceted slabs. These slabs were then treated and sprayed with molten copper in the shop. They were then sent to the job, erected on centering and concrete poured to hold them in position.

The building is heated by means of radiant tubes located under the terrazzo finish of all floors. A 250-ton absorption machine utilizes steam heat and lithium bromide in



The view above shows some of the intricate precision formwork at the windows of the basement-level lecture room. Since most of the concrete in the structure is exposed, elaborate care was exercised to achieve the utmost accuracy and the finest possible surface texture.

a chemical process for the air conditioning system.

Although he has designed some 700 buildings in all, this is the first major project Frank Lloyd Wright has built in New York City. His representative on the job is William H. Short. The general contractor for the entire structure is Euclid Contracting Corporation of New York City. The work is being done under the direction of George N. Cohen, assisted by Joseph Neukrug. Charles W. Spero is job superintendent and project manager.

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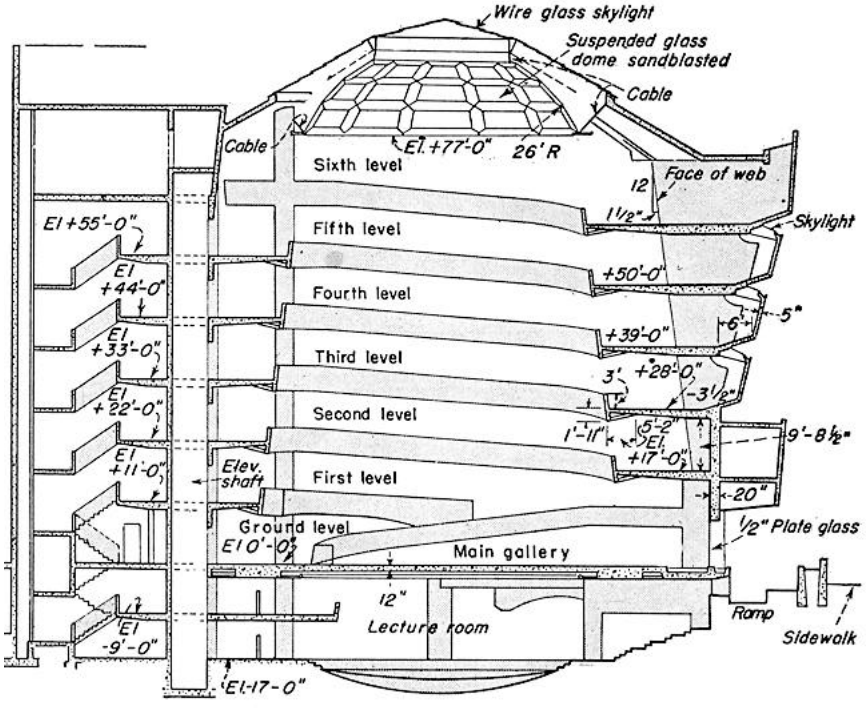
* Mr. Cohen is president of Euclid Contracting Company, New York City, general contractor for the Guggenheim Museum.



Cross sectional view of the Museum wing showing how the spiral ramp is employed to give access to the art displays along the outer wall at the right. At the first floor level the ramp has an inner radius of 32 feet and an outer radius of 48 feet, while at the fifth level the inner radius has decreased to 25 feet and the outer radius has increased to 57 feet. Starting at the main-gallery level, the ramp rises 11 feet with each complete revolution.

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