ARCHITECTURE
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THE PYRAMID COMPLEX AT GIZEH, EGYPT

This issue's limited edition signed print by Ladd Ehlinger is of most of the tomb architecture at Gizeh, near Cairo, Egypt. Shown in the sketch from right to left are the Pyramid of Chephren (Khafra), the Mortuary Chapel of Chephren, The Great Sphinx of Chephren, and the Pyramid of Mykerinos (Menkaura). All of the structures at Gizeh date from the Fourth through the Sixth Dynasties (c. 2800 BC to 2500 BC) of the Ancient Kingdom (Dynasties I-X, c. 3200 BC to 2130 BC), and were built as tombs, mortuary and chapel structures for the Pharohs and other royal personages of ancient Egypt.

There are three large pyramids at Gizeh, the largest of which is that of The Great Pyramid of Cheops (Khufu), which is not shown in the print. Also not shown are the various mastabas, small pyramids, rock tombs, Valley Buildings, and causeways at the complex, as it is too vast to encompass in one view. The architects for the various buildings at Gizeh are unknown. The only known architect from the Ancient Kingdom period is Imhotep, architect of the earlier Pyramid Complex of the Pharoh Zoser at Sakkara. He was also the first known medical doctor, and was revered in his own time and later times, so much so that he was deified in the Twenty-Sixth Dynasty.

The purpose of the pyramids was to preserve the mummy of the royal Pharoh for the return of the soul in the infinite hereafter, and also to be the center of a cult of the royal dead, and as a consequence, the dominant element in this vast monumental complex.

The Pyramid of Chephren is the second built of the three at Gizeh, and is only slightly smaller than the Great Pyramid. It measures 708 feet per side, 470 feet high with side slopes of 52 degrees, 20 minutes. There is only one burial chamber in the core, but there are two approaches to it from the north: one subterranean and the other through the stonework, that join halfway. Much of the original limestone casing or finish surface is visible at the apex, as are fragments of the base course facings of granite. The remainder of the complex is well preserved also, such as the mortuary chapel and the Sphinx visible in the print.

The Great Sphinx of Chephren is a colossal enigmatic monster carved from a spur of rock left by the quarry masons that worked on Cheop's complex. The head is of Chephren wearing the royal headdress, false beard and cobra brow ornament with the body of a recumbent lion. The sculpture measures 240 feet long by 66 feet maximum height, with the face being 13.5 feet across. Voids and deficiencies in the native rock were made good with stonework blended in. Between the paws is a large granite stele, which records a restoration made by Thothmes IV (1425 BC), of the Eighteenth Dynasty.

The Pyramid of Mykerinos is much smaller than its two predecessors at Gizeh, measuring 356 feet square in plan by 216 feet high, with the sides sloping at an angle of 51 degrees. Much of the casing of Tura limestone is preserved along with sixteen base courses of granite.

LICENSES

Congratulations to Emanuel Smith, of E & A, who recently received a Louisiana Architectural License.

SAVE THE SLOPES

This issue's E&A CADD drawings are custom homes in south Huntsville designed to minimize slope damage, preserve the trees, and capture the mountainside view.

THE RAIN SCREEN PRINCIPLE:

PREVENTION OF WATER LEAKAGE

The rain screen principle is a method of preventing water leakage that attempts to minimize or eliminate the forces that cause water leakage through openings in the wall and/or roof surfaces of a building, rather than to eliminate the openings in the surface (often an impractical, if not impossible practice). It is a delicate method of design and a clear understanding of its workings is essential.

There are six basic ways that rain can penetrate an opening. The first is simple gravity. The second is kinetic energy - wind, for instance. Surface tension is another, most easily understood by placing one's arm straight out to a water faucet and watching the water run horizontally past one's elbow. The fourth is capillary action; this occurs when an opening is relatively small and, in essence, "draws" the water into the wall not unlike a blood vessel drawing blood, as the name suggests. These forces are relatively easy to design against and have been dealt with successfully with conventional methods.

The last two forces are the most critical, and most difficult to deal with. Air currents, resulting from differences in wind pressure over a wall surface, often carry water through a wall. These currents can be surprisingly unorthodox, even resulting in an upward movement of water. The sixth is pressure difference; if water is present on the exterior of a wall, and the air pressure is greater on that side than the other, the water will seep through any opening that may be present. The typical way of preventing these forces is to simply seal off the opening, but a more effective way is to eliminate pressure differences on either side of the wall. After all, if the pressures are equal on either side, then there is not and force and, consequently, no water penetration.

In order to do this, one must create an open air space, a cavity, between the exterior facing of the wall and the interior of the building to equalize the pressure of exterior air and cavity air. Strangely enough, one must leave joints unsealed, purposefully leaving many or all of them open!

This way, communication of the air on the exterior with the air in the cavity creates a barrier that provides a buffer preventing water penetration. However, it is not simply a matter of "ventilating" the wall; the cavity (air barrier) must be a confined space, communicating only with the exterior.

This is where design problems occur and where many buildings fail. There must be an interior barrier in the cavity which is sealed to the interior of the building to prevent the passage of water, air, and vapor from the cavity to the interior of the building. The unsealed holes between the cavity and the exterior must provide adequate drainage for the air screen, usually accomplished with weepholes, to allow the water that enters the cavity to escape to the exterior, as well as allowing for the rapid equalization of air pressure between the cavity and exterior that is required.

The rain screen principle is easily demonstrated with a conventional exterior wood frame wall or roof with wooden shingles. The overlapping of the shingles creates unsealed joints that are open to the weather, permitting the space between the shingles and the sheathing (the interior surface) to be pressure equalized.

Another example of a material assembly that utilizes the rain screen principle is the common residential wood frame brick veneer wall. The brick veneer allows for controlled leakage, through seepage of water through the pores of the brick and mortar. In cases of poor brickwork, leaks occur through cracks in the mortar. The water that does penetrate flows by gravity down the inside back face of the brick in the air cavity, to the weepholes, and weeps back out of the assembly to the exterior. The weepholes also allow for pressure equalization of exterior air to cavity air. The sheathing attached to the wood stud portion of the wall never gets wet, provided the joints of the sheathing are sealed.

Common errors in the design and construction of brick veneer walls are unsealed sheathing, too narrow an air space (less than 2"), mortar bridges (mortar spanning from the brick across the air cavity to touch the sheathing), and inadequate weepholes (mortar plugged or non-existent weepholes).

The newest material assembly utilizing the rainscreen principle is the modern day glass curtain wall system that is "dry glazed". The glass is mounted in the metal frame by rubber gaskets only (dry glazed) in a glazing pocket (air cavity) within the metal frame that is sealed to the interior of the building by an elastomeric type sealant ("wet sealed"). The cavity has weepholes to the exterior for air pressure equalization and "weeping" of water which does penetrate into the cavity from the pressure seal of the rubber gaskets against the glass.

Common errors in the design and construction of curtain walls are lack of the proper amount and/or placement of cavity sealants, parts missing such as internal water diverters or flashings, oversized or undersized glass, improper seal of gaskets to glass due to wrong gasket size or inadequate pressure of gasket to glass from the frame itself, and poor juncture and flashing of the curtain wall to adjoining materials.

The rainscreen principle is not new, but has only recently been studied scientifically. Few understand how it functions, and even fewer actually use the practice in a manner that truly prevents water leakage. The rain screen principle must be thoroughly understood for its effective use, which can only be achieved sometimes by empirically testing an assembly mockup in a laboratory before use in the actual building.