Above: One Shell Plaza (Skidmore, Owings & Merrill and Wilson, Morris, Crain & Anderson, 1971) as viewed from Hermann Square.
Opposite page: Joseph Colaco at the base of One Shell Plaza.

Photo © 2006 Eric Hester

35 Years of One Shell Plaza

Once the world's tallest concrete building, One Shell Plaza still has lessons to teach

INTERVIEW WITH JOSEPH COLACO BY WILLIAM F. STERN AND CHRISTOF SPIELER

When it was finished in 1971, One Shell Plaza was the world's tallest concrete building. The 715-foot, 50-story building, which fills the block bounded by Louisiana, Smith, Walker, and McKinney, was also Gerald D. Hines' first project in downtown Houston, and it drew attention not only for its size, but for the close collaboration between design architect and chief engineer. As principal and founder of his own firm, CBM Engineers, and as a teacher of engineering to architecture students at the Univeristy of Houston, Joseph Colaco knows structural engineering firsthand. He worked as project structural engineer on One Shell Plaza, and watched as its structural innovations took root. To mark the 35th anniversary of the building, Cite *editorial board members William F. Stern and Christof Spieler sat down with Colaco to talk about One Shell Plaza, the collaboration between architects and engineers, and how that has changed since the building was constructed.*

CITE: Looking back on it now, what does One Shell Plaza mean to you?

JOSEPH COLACO: It means a whole lot to me for a whole lot of reasons. One was that at the time it was built it was the tallest concrete building in the world. It was a very innovative structural system. There was a great deal of research done on this project, research that has served the industry well over many, many years. And then when I moved to Houston in 1969, the building was just about finished. For the last 35 years, I have been involved in whatever tenant work and changes that have been made on the project. So it has been a project that I have been associated with for almost 40 years now.

CITE: How does One Shell Plaza fit into the evolution of high-rise structures?

COLACO: Dr. Fazlur Khan, my boss at SOM [Skidmore, Owings & Merrill] at the time, essentially developed the catalog of structural systems based on general heights of buildings. For heights up to about 30 stories, we could generally use what we call a frame type structure. Once you get up in the 50-story category, you have to tie two structural systems together and do a shear wall with a frame, what he termed the tube-in-tube type system. And once you keep getting higher than that, you get closer to 75 to 100 stories tall, you do what we call a tubular design, which is where all of the resistance is put on the exterior of the building. One example of that design is the John Hancock Center in Chicago. Another is the World Trade Center, which unfortunately collapsed. That was a frame tube, where you have columns and beams welded together at very, very close spacing. The World Trade Center had columns that were three-feet-four-inches on center on the outside and a very deep spandrel beam. Essentially, you could look at the façade as a sheet of steel with punched rectangular windows. It was built as a column/beam system, but it was actually just a sheet of steel with openings. In that respect, it was similar to One Shell Plaza. If you step back and look at One Shell Plaza, the columns are six feet on center with a very deep spandrel, just with rectangular openings, so it is a perforated tube on the outside. The difference between One Shell Plaza and the World Trade Center was that we also have a core in One Shell Plaza made of concrete walls. And in the World Trade Center, there was no core. The entire resisting system was in the perimeter of the building. One Shell Plaza, being 50 stories, falls in the intermediate category where you have a tube in tube. You have a shear wall core, which forms one tube, and then you have a perimeter column and beam system, which is a frame, and forms a perimeter tube. In the pantheon of structural systems, it's right in the middle.

CITE: How has this catalog of systems changed since One Shell Plaza was built?

COLACO: The biggest change was when the post-modern movement came about. Before that we had basically a Miesian-type design, which some call International Style. Buildings were fairly regular. They were rectangular, they pretty much went straight up and down, and so you could develop a whole family of structural systems that suited that kind of design. When you have the post-modern type architectural expression, you very seldom get the opportunity to do a perimeter frame system, because the structure does not go up straight from top to bottom. So you have to come up with different types of systems.

CITE: One Shell Plaza is concrete, while most of the buildings Fazlur Khan is known for are steel. What led to the choice of material?

COLACO: SOM had done a 38-story building called the Brunswick Building in Chicago. It was an all-concrete building. And what that developed was a style that combined structure and architecture into one expression. When you can develop a combined architectural/structural system, not only is it aesthetically pleasing and makes sense, but you get the benefit of having the architectural elements, like the skin of the building, provided in the structural frame. You develop a lot of economies. So when they started talking about One Shell Plaza, that theme

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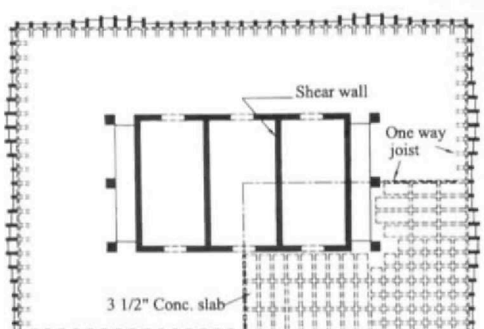
Photo courtesy Joseph Colaco



Top: One Shell Plaza under construction. The sign touts it as the "South's tallest building" at 50 stories.
Above: Concrete trucks line up to pour the foundation of One Shell Plaza.
Left: Floor framing plan, One Shell Plaza, showing the major structural elements: the shear wall core, the exterior wall with its distinctive waviness, the one-way joist system at the sides, and the two-way grid system at the corners.
Below, left: Engineer Fazlur Khan (left) and architect Bruce Graham with a model of the John Hancock Center, one of the buildings they collaborated on.

Photo courtesy Skidmore, Owings & Merrill LLP

of combined architectural/structural expression came about. If you look at the design, you will see that the building is clad with travertine. And right behind the travertine is a concrete frame that exactly mirrors the travertine exterior system. The glass is essentially placed within the concrete frame, so you do not have to provide an expensive aluminum system to hold the cladding in place. The concrete structure, in effect, is the backup system for all the travertine and glass.

CITE: Tell us about the way the building curves out at the corners.
COLACO: The reason the building curves out at the corners has to do with the way the gravity loads and the weights of the floors are transmitted to the exterior columns. One Shell has got very closely spaced columns. They are six feet on center along the façade, and going through the building you have 36 feet between the outside column and the core. The core is 60 feet deep, and another 36 feet on the other side. When you come to the corners, you have a two-way system, and when you have a two-way system, the loads that come from the floors get concentrated in the column bands that are at the ends of the grid and not in the corners. If you accumulate this load over 50 stories, those columns have much heavier loads than the columns going towards the corner on the façade, and so they have to be made bigger in order to keep the stress level on the columns all the same, which is a guiding principle of tall building design. In this particular case, the decision was made to express that difference. And that became the expression of the building. So you have a slight waviness of the façade, because the columns are bigger.

CITE: What was your role on the project?
COLACO: I was what we call the project structural engineer. Fazlur Khan worked primarily with the design architect, Bruce Graham. They collectively decided on the shape of the building, the structural system, and the materials from which the building was going to be made. And once these decisions were made, in conjunction with Hines of course, my job was to implement that concept all the way to working drawings and construction services.

CITE: How did you decide that you wanted to be a structural engineer?
COLACO: I was in college at the University of Bombay in India. My father was head of the English department at the same university. I was interested in becoming a medical doctor, but in my freshman biology classes I found that the sight of blood makes me very nervous. So I told my dad that that was not for me. I was good at mathematics, though, and when my father asked what I wanted to do, I said that engineering sounds like a thing I could fall into. And so my dad went to check with some of his friends, and India was in a tremendous kick at the time with construction projects coming out all over the country.

CITE: When was this?
COLACO: I'm talking about 1955-1957. By the second year of college I'd pretty much decided to go to engineering school. I got admitted to another college, also in Bombay, and the nice thing about that college was that there were all different branches of engineering—civil, mechanical, electrical, textile, and chemical. All these had the same curriculum for the first year. But by the second year I had to choose. And very quickly I came to the conclusion that civil and structural were where I wanted to be because I liked buildings, and I liked to be outdoors, and I liked to see things finished. After I graduated I worked for a year for a British company in India. Basically my job was to set up a pre-cast concrete factory in Bombay. And then I came to the University of Illinois for graduate work. And that's where, when I was finishing up my PhD dissertation, Dr. Fazlur Khan called. His former advisor was my advisor. That was in 1965.

CITE: Fazlur Khan is probably one of the best-remembered structural engineers in U.S. history. What can you tell us about him?
COLACO: Dr. Khan was an engineer working at SOM in Chicago. He got his PhD at the University of Illinois, I think in 1955. And it just so happened that his thesis advisor was the same advisor I had ten years later. He had called down to the University of Illinois looking for an engineer to help him out with the design of the John Hancock Center, and I was sitting with my advisor at the time. So he suggested I go to SOM and talk to Dr. Khan. I worked for him for four years. He was, by far, the most innovative engineer I've ever met. And even to this day I can make that statement without any second thoughts. He was also, few people know, one of the hardest working engineers I've ever seen. Even when I worked for him, he had me doing essentially three jobs. Dr. Khan was also an adjunct professor in the college of architecture at the Illinois Institute of Technology, and he had me helping him over there. Then when one of his friends called up and wanted someone to teach at the University of Illinois, he had me running over there teaching a course. And all the while he wanted me to do research and write technical articles and give speeches and so on and so forth. He did that himself. He was a workaholic. I have very, very fond memories of him. On a

personal note, when I decided to get married, I asked him to raise the toast at the wedding. He was very flustered, because he was a very good technical speaker, but didn't know much about social things. He agreed to do it, and I wish I had recorded his talk, because it was one of the most brilliant talks I've ever heard at a wedding. He was just a very brilliant man.

CITE: What kind of relationship did Khan have with the architects at SOM?
COLACO: With Bruce Graham, One Shell Plaza's architect, he had a very, very intimate relationship. At first it started off being a straight professional relationship with an architect and an engineer. As things evolved, Bruce began to see that Fazlur was a very innovative gentleman, and he would actually try to develop the building jointly with Fazlur. Earlier, you asked a question about why we have a slight waviness in the base of One Shell Plaza. Well, that was a structural thing. Fazlur explained to Bruce, "We have these columns with different loads, why don't we express this thing?" Bruce said, "Okay, let's try it. You come back to me with a diagram that makes the most structural sense, and I will see if we can express it architecturally." So they became a team. It was a very close connection. It was not a hand off type situation between an architect and an engineer, but one where they could collaborate, where they would bounce ideas back and forth off one another. And that relationship was unique. Fazlur and Bruce Graham became almost a single entity when they talked to each other.

CITE: How did One Shell Plaza fit into the overall arc of your career?
COLACO: I joined SOM in 1965 and started working with Bruce Graham and Fazlur Khan on the John Hancock Center. We were just finishing that up when Gerald Hines came to Chicago with his proposal for One Shell Plaza. So my second job at SOM was to work on One Shell Plaza. After that, I did a lot of buildings for SOM. In the South I worked on Two Shell Plaza, the Control Data Building, and the One Shell Square project in New Orleans. In Philadelphia I worked on a big stadium called the Spectrum. In Chicago I worked on the Picasso Sculpture and worked on the transit system. There were a variety of projects that came across my desk in the four years I was at SOM.

CITE: What prominent Houston buildings were you the structural engineer on?
COLACO: Maybe I should do this chronologically so I can think of all of them. One of the first tall buildings I did downtown was One Allen Center. Then I did Dresser Tower, which is now I believe the Kellogg Tower. Then I went on to work on the Pennzoil Building. The Republic Bank is now the Bank of America. Texas Commerce Bank is now JP Morgan Chase. The Wortham Theater downtown. Then the United Bank Building, I don't know what it's called now. Remodeled the 1100 Milam Building into the headquarters of Reliant Energy. 1100 Louisiana building, did the Holiday Inn downtown. Several buildings like that. I worked on the Transco Building, which is now the Williams Tower. And many, many other buildings that are on the West Loop.

CITE: You talked about the impact of the expressed structure on One Shell Plaza. Are there any others that you worked on where the structure is manifest?
COLACO: The closest one is the 75-story JP Morgan Chase Building, for which I.M. Pei was the design architect. What you see there is the structure and the architecture marrying perfectly. That was the closest collaboration I have had since I left SOM.

CITE: Why did you leave Chicago to come to Houston?
COLACO: There were a lot of reasons I left SOM. One, in order of priority, they proclaimed themselves to be architects and then engineers. Even Fazlur Khan was not being promoted to be a partner. I finally began to see the handwriting on the wall. I left SOM in 1969 and moved to Houston and joined a small company, and then helped start 3D/International. From 1972 to 1975 I was on the board of 3D/International. The original name was Diversified Design Disciplines, and they shortened it to 3D/I. In 1975, I started my own firm.

CITE: What is happening now with your practice?
COLACO: I'm slowing down my practice, to be honest. I'm spending less time with my practice, spending more time with the University of Houston, just balancing it all.

CITE: You're relatively rare among engineers in that you have relationships with architects and teach in an architecture school. How did that happen?
COLACO: When I was working at SOM, Dr. Khan was an adjunct professor at IIT. So he very frequently called me in to help him with the classes and students. At SOM I was working with the architects on their projects. So it was a natural move to work with architects at an academic level. When I came to Houston, I tried to maintain that same relationship. I tried at Rice, and they would not take me at Rice, because they already had Nat Krahl. So I started teaching at the University of Houston in the college of architecture as an adjunct professor. Eventually I also taught at Rice when Professor Krahl passed away.

CITE: You've been involved with architectural education and hired structural engineers straight out of school. Do you find the students prepared to collaborate?
COLACO: There's very little training that architects get on structural matters. I'm trying at the University of Huston to integrate that right now. But generally, unless universities have courses that are well-grounded in engineering principles, engineering materials and, more important, engineering concepts, architects do not get very well-grounded in that field. And unfortunately, in the post-modern movement the general feeling is that technology becomes secondary. It is not at the cutting edge of things that are required. The icons that modern students have are probably of a different generation of people who believe that technology is really secondary. I've tried hard to disabuse them of that notion. And we've succeeded. Most of the students that I've dealt with over the last 30 years have come away with the feeling that if you know technology, you'll be a better architect for it.

CITE: You described the common relationship between architects and engineers as a "hand off." Do you wish it were more like it was on One Shell Plaza?
COLACO: Yes. You just don't have the same creative juices going when you just hand off a project. Then the structural engineer's goal is to essentially be sure that you develop a structure that is safe, which is a necessary goal, but you don't have a hand in the creative process. The creative process is much diminished. You are trying to make something fit an architectural mold. It is different from being called in at the front end and saying, "Come, let's work this together."

CITE: Is there a reason it has to be this way?
COLACO: In America, development is in a post-modern movement. In the 1960s to 1980s, when we had more the International Style, more the Miesian style, there was a logical evolution of structural system. There was a rationale where people in the building business understood that a building has got a lot of important elements to the design, and one of them is structure. As a building gets very tall, the structural design controls a great deal of the cost of the project. And if you have an integrated system between the architect and the engineer, you can develop something that is unique and very satisfying from an overall standpoint. In the post-modern design, the building shape and design results from less rigorous engineering methodology, and then you are always making sure you can come up with a reasonable, economical system, and make it stand up.

CITE: Are there any architects you'd be happy to work with again and again?
COLACO: Well, the ones that stand out the most are I.M. Pei and Cesar Pelli, for a whole lot of different reasons. I.M. Pei is, in my judgment, one of the most consummate architects, because he understands not only architecture, but he is also very involved in technology. He knows how to ask the question that excites engineers. For example, he wanted to know about motion perception.

CITE: About what?
COLACO: Motion perception. How or why people get seasick in very tall buildings. This is something that every tall building engineer knows, but very few architects ever ask about. And he immediately came out and asked, "How are you going to take care of motion perception?" You get an architect who asks you those fundamental type questions, and you say, "Wow." Cesar Pelli, on the other hand, is wonderful to work with. Not only is he a very warm-hearted and generous person, but he's also very, very sharp. When you sit down and explain something to him, his mind immediately focuses on, "How can I do this?" These are two of the architects that I find very exciting to work with, and I am still working with them in some places.

CITE: Returning to One Shell Plaza, I should ask about the antenna.
COLACO: Since at the time One Shell was the tallest building in Houston, the antenna was part of the program to take care of electronic transmissions. And we had to provide an antenna tube, which was close to 200 feet tall above the roof of the building. It was an extremely heavy antenna tube—six feet in diameter, with two inches of steel wall thickness for the tube. And that was required not so much for strength as to control the sway of the antenna, which is required to prevent distortion of electronic signals. Well, it outlived its usefulness, and about three or four years ago, the question came up from the building manager, can we take it down? We spent quite a few months thinking how to take down an antenna tube that weighs almost one ton per foot off of the top of the building. And after a great deal of study, it was decided that it would be impractical to do it. The next alternative was to leave it in place, retrofit it, clean it up, take off all the rust spots, and so on, and then have it essentially painted and left in place, primarily because the building, over the last 35 years, had that antenna tube, and most people see it as one of the elements of the building. So there it sits right now. The antenna tube is still on top of the building. ■