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Newer Structural Systems and Their Effect on the Changing Scale of Cities

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Shear Wall Frame Interaction

The behavior of the shear wall in conjunction with rigid frame of the remaining part of the structure was not fully utilized until very recently. The first design application of the shear wall frame interaction was used by the author in the 38-story Brunswick Building (figure 12) in 1962. The interaction curve shown in figure 1 in fact was first developed for concrete buildings by the author. One of the advantages of the shear wall frame interaction system is that it exists in every reinforced concrete building with shear walls whether the frame is deliberately designed for it or not simply because every joint in a reinforced concrete structure when cast monolithically acts as a rigid frame. The engineer therefore should take advantage of this system for all concrete buildings using shear wall construction.

In the development of the Brunswick Building an important advancement was made by arranging the floor plan in a way that between the central service core enclosed by the shear wall and the exterior closely spaced columns (9′4″) the 38-foot clear space was without any interior columns. The closely spaced exterior columns in reinforced concrete do not have the same high level of premium as experienced in closely spaced steel column systems. However, the advantage of closely spaced columns in the concrete structure is that the traditional metal curtain wall can be eliminated and the glass window can be simply installed directly supported by the structure itself. This particular advantage in simplifying the curtain wall and reducing its cost led to some subsequent developments which will be discussed later. It can only be pointed out now that to compare the structural systems, one must consider the curtain walls in the total cost.

Framed Tube

As discussed earlier, the first framed tube concept for tall buildings was used by SOM for the 43-story DeWitt Chestnut Apartment Building in Chicago as shown in figure 13. Because the apartment building has smaller floor plan width and does not have large service core to provide for a stiff shear wall, the entire lateral stability of this building was achieved by spacing exterior columns at 5′6″ centers and providing the interior columns wherever needed to support the 8-inch thick flat plate concrete slab. The resulting building indicated large savings because of the flexibility of the interior core and the incorporation of the window wall system into the structure itself. More buildings are built today with this concept because of the savings advantages.

Tube-In-Tube System

When faced with the challenge of developing an optimum economical solution for the 52-story One Shell Plaza Building in Houston, the author combined the framed tube concept with the shear wall frame interaction concept to devise a structural system consisting of an exterior very closely spaced column system (6-foot centers) together with a rigid shear wall core enclosing the central service areas as shown in figure 15. This tube-in-tube system made it possible to design the 52-story One Shell Plaza Building at the unit price of the traditional shear wall structure for only 35 stories. The resulting building, now finished, stands at 715-feet high above ground level and is the world's tallest reinforced concrete building (SBZ *92* (1974) H. 6, S. 108, Bild 4).

Bundled or Framed Tube

Inasmuch as closely spaced column systems are easy to build in reinforced concrete and are more economical compared to the closely spaced steel structural framing, the author believes that the mega-module system will be used efficiently for future high rise concrete buildings in the range of 75 stories. Since no building is actually being planned with this concept, further discussions of this system should be left for a future report.

Systems Approach

The term "systems approach" has perhaps become a jargon in today's vocabulary. Nevertheless, the concept of systems approach used by the Aerospace Agency and in the recent developments in other industries can and should be used for developing more efficient structural systems for tall build-

Figure 12. 38-story Brunswick Building (1962)

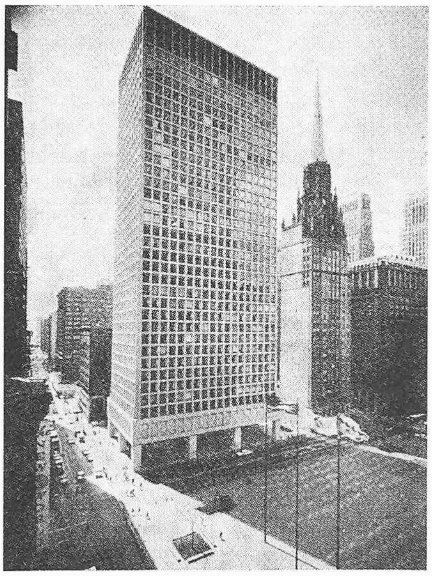


Figure 13. 43-story DeWitt Chestnut Apartment Building in Chicago

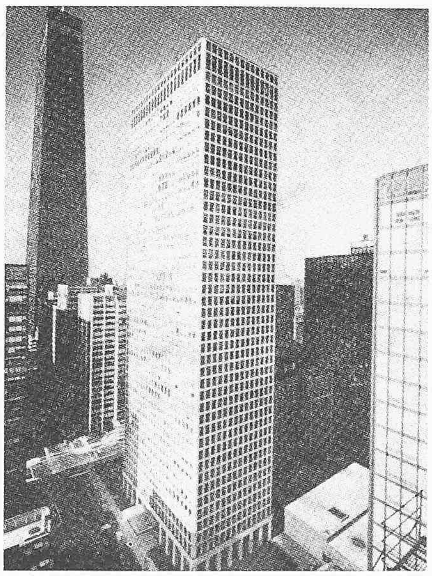


Figure 14. 52-story One Shell Square Building in New Orleans

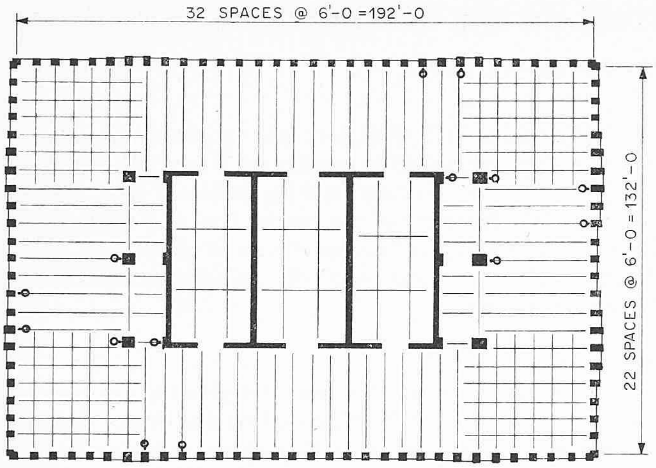


Figure 15. Tube-in-tube system. Very closely spaced columns and a rigid shear wall core enclosing the central service area (52-story One Shell Plaza Building in Houston)

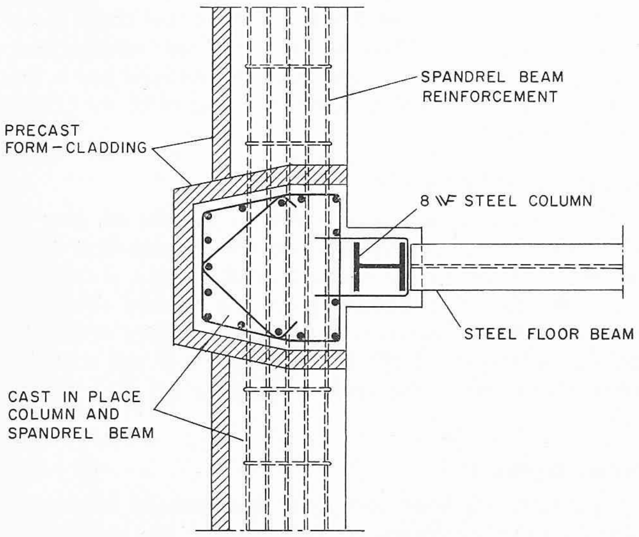
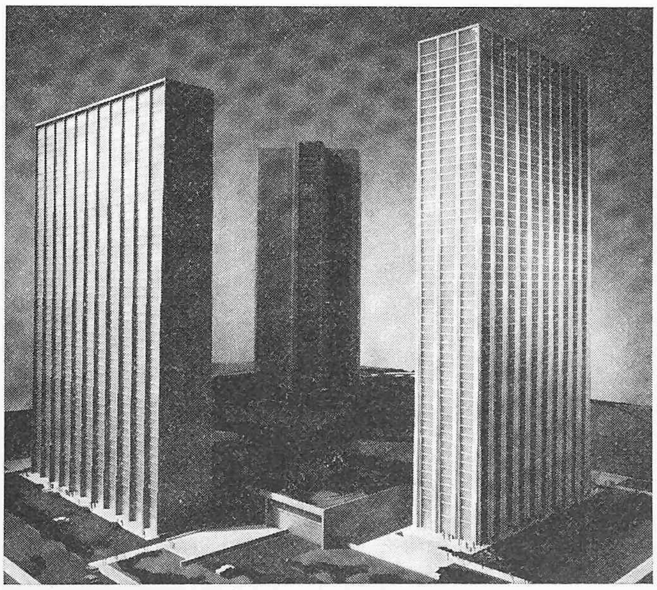


Figure 16. In the «Composite system» the exterior is formed of reinforced concrete: closely spaced columns and spandrels as well as the curtain wall

Figure 17. Project consisted of three buildings all about 700 feet tall made of masonry walls (by two graduate students of the Illinois Institute of Technology)



ings. One of the significant contributions of the systems approach is that a system may be the result of the optimization and advantages of many other sub-systems in element as well as in materials. Searching for newer structural systems for tall buildings, a number of interesting observations were made by the author. The first observation was that in reinforced concrete tall buildings the use of exterior closely spaced columns was an efficient and ideal solution both for structure and the curtain wall. On the other hand, in such structures the central shear wall core drastically reduced the flexibility in planning and utilization of the area. For instance, when elevators drop off at different height levels the free space cannot be retrieved in an efficient way because the shear walls cannot suddenly be eliminated. In tall steel structures the most important advantage, is that the structure can be built at a relatively fast speed, generally one floor every three days, whereas in concrete construction even one floor every seven days is an optimistic projection. In steel buildings the central cores are much more flexible than in the concrete building and any free area due to dropping off of the elevators can be immediately utilized as a fully rentable area by adjusting the partition walls as necessary. On the basis of these observations, the author concluded that there must be a way of combining the advantages of a steel structure with the advantages of the concrete structure, thereby eliminating also the disadvantages of the steel structure and the disadvantages of the concrete structure. This is actually what led to the "Composite" system. The Composite system consists of the structural steel columns, beams and floor construction whereas the exterior closely spaced columns and spandrels together with the curtain wall is formed of reinforced concrete as shown in figure 16. In order to keep the rate of construction equal to the normal rate for a steel building and also to keep the structural steel trade separate from the reinforced concrete trade, it was decided that the entire structure in steel should be built ahead of the exterior concrete structure cladding. This system was first tried on the 24-story CDC Building in Houston by the developer, Mr. *Gerald D. Hines,* of Houston. In this building, precast concrete window panels were used to act also as the formwork for reinforced concrete exterior system. The author is happy to note that the construction rate was as predicted, which is three days a floor, and economically the project has been a great success. Two other major buildings have been designed by SOM and are now being built with this system, namely the 45-story Union Station Building in Chicago and the 52-story One Shell Square Building in New Orleans.

Load Bearing Brick or Concrete Masonry Block System

Even though bearing wall type construction was the earliest development in building technology, use of steel and later of reinforced concrete somewhat overshadowed brick and masonry bearing blocks for the last 75 years.

It is, however, interesting to note that one of the earliest skyscrapers in Chicago was the 16-story Monadnock Building, which is still one of the world's tallest masonry wall constructions. Only recently there have been some fresh efforts made, notably in Switzerland, where highrise apartment buildings have been successfully built using concrete bearing blocks. In the United States a number of hotels and apartments, up to about 16 stories, have been built using reinforced masonry blocks.

The realization that the application and potential of bearing block construction has been neglected for such a long time, the author undertook over the last year to develop a fresh approach to tall concrete masonry block construction. The research was sponsored by the National Concrete Masonry Association of America. The investigative work was done at the Illinois Institute of Technology by two graduate students working under the advisorship of the author, and the results nave been very optimistic. Concrete masonry blocks, as a distinct material for construction, seems to produce its own natural forms and shapes of buildings both for residential and for commercial use. The IIT project consisted of (figure 17) three buildings all about 700 feet tall made of reinforced masonry walls, arranged to satisfy the basic architectural, structural, and functional needs. Further work is being conducted to evaluate these preliminary studies in more detail so that they may form the basis of future constructions. Additional testing program is also being conducted at the Portland Cement Association to fully understand the behavior of these bearing wall structures under long term loading.

Conclusions

The development of newer systems and newer methods of construction will continue as response to newer challenges for better urban environment in the future[1]). As was discussed in the beginning of this paper, the ultimate justification of taller buildings from the social point of view will be their effectiveness in creating better environment while allowing the cities to grow in density. Instead of creating bulky medium-rise buildings causing the urban canyon, the taller buildings used in a more sensitive way, can open up large ground level spaces, letting in more air and sunshine, and stimulating more human activity at the ground level. It will be only possible to have these alternatives if structural systems can continue to be developed that will allow the construction of a taller building for relatively same unit prices as the shorter ones of the past.

[1]) Weitere Angaben über die hier beschriebenen Bauten finden sich in der Firmenveröffentlichung, die auf Seite 1056 dieses Heftes besprochen wird.

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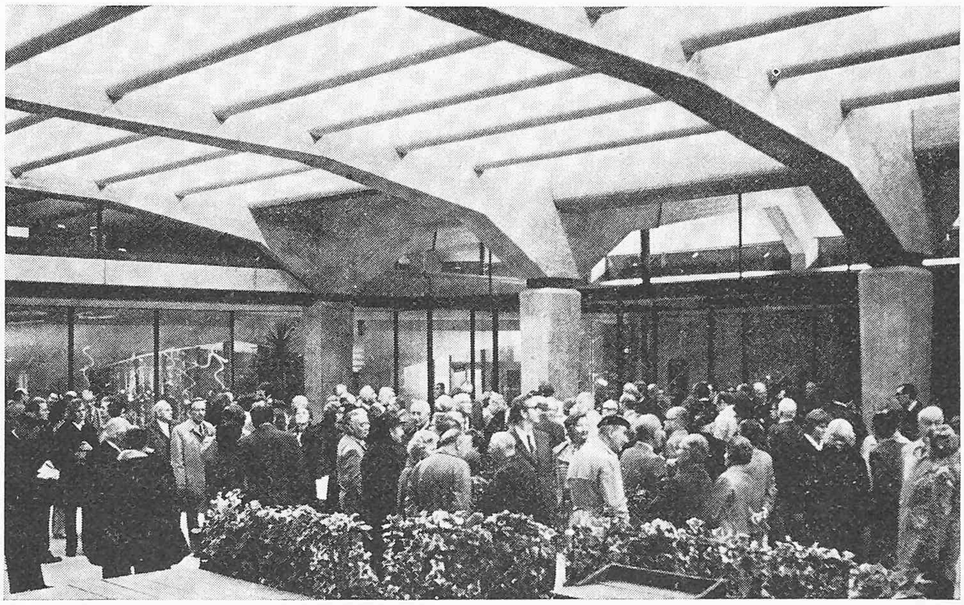
Generalversammlung 1974 der GEP in Lugano

DK 161.2:62

Vom 17. bis 19. Oktober trafen sich die Mitglieder der GEP zur sechzigsten Generalversammlung in Lugano, wo die Gesellschaft letztmals 1946 getagt hatte. Zur rund 300 Mitglieder und Begleitpersonen zählenden GEP-Familie gesellte sich erstmals ein stattlicher Harst (insgesamt etwa 60 Personen) der *A*ssociation *A*micale des *A*ncien *E*lèves de l'*E*cole *P*olytechnique Fédérale de *L*ausanne (A^{3}E^{2}PL). Und da auch die GEP-Gruppe Tessin als Gastgeber aktiv präsent war, kam es zu einem wahrhaft nationalen Generalversammlungsaufmarsch, zumal die vierte Schweiz der Rätoromanen in der GEP ebenfalls vertreten ist. Um es vorwegzunehmen: Das gemeinsame Treffen der Ehemaligen beider Technischen Hochschulen verlief dermassen kollegial und angenehm, dass danach getrachtet werden soll, künftig die Generalversammlungen beider Vereinigungen nach Möglichkeit – wie diesmal – zu kombinieren, d.h. den Versammlungsteil getrennt durchzuführen und die Veranstaltungsschlacht vereint zu schlagen. In den Annalen der GEP wird die Generalversammlung 1974 als denkwürdig vermerkt bleiben.

Der Gotthard als Wetterscheide machte das Wunder abermals wahr: Sonnenglanz begrüsste in Airolo den Reisenden, der aus der Kälte kam. Im Hotelzimmer winkte zum Empfang eine Flasche «Merlot». Daneben eine kleine Mappe als freundliches Angebinde der Schweizerischen Bankgesellschaft (nicht zur Schleichwerbung sei's gesagt) mit allem Notwendigen an Programmen, Gutscheinen, Prospekten usw. Hinter diesem sorgfältig und wohldurchdacht zusammengestellten Versammlungsdossier steckte eine grosse, zugleich minuziös geleistete Vorbereitungsarbeit des Tessiner *Organisationskomitees*. Dessen treibende Kraft und Seele war unzweifelhaft Ingenieur *Franco Ender* junior, presidente del GEP Gruppo Ticino, der in der Folge auch um den guten Verlauf des ganzen Geschehens unermüdlich bemüht war.

Im grossen Studio der von Architekt A.E. Jäggli reizvoll im Quartier Besso eingebetteten Bauten der *Radio Svizzera Italiana* begrüssten die Präsidenten *Rudolf Steiger* und *Eric Choisy* das Gros der Teilnehmer aus beiden Ehemaligenvereinen. Musikalische Darbietungen umrahmten den offiziellen Eröffnungsakt.



Die Ehemaligen werden von der Stadtbehörde Lugano im noch unvollendeten Kongresshaus empfangen