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Summary

Jürgen Joedicke

Shell Construction

Shell Construction as an Architectural Means

(page 406)

There are few fields in modern architecture that arouse as much interest on the part of architects as that of the design and building of shell constructions. But there is hardly any other field in architecture that appears to be so elusive. There is a considerable number of publications dealing with problems of statics in shell construction. These books are written exclusively for engineers, in fact—to be more precise—for that small circle of engineers who have specialized in the calculations going in hand with shell construction. But even if the architect were to go to the trouble of working through these books, he would find little stimulus therein, for the design problems arising from the play of forces are not touched upon and, furthermore, these books generally limit themselves to the same prototypes in shell construction—cylinder and rotation shells. If you add to these shapes shells in the form of translation surfaces, then the field of the shapes of shells in general use is already exhausted. But as a shell regarded as a singly or doubly curved surface can have any desired function of x, y and z, there is an infinitely large number of possible forms. What has not been explored is their individual significance and the new openings they offer for new methods of design.

In order to show what is possible in shell construction, the examples in this issue have been specially selected as being distinct from ideas that are generally well-known. When we are trying to determine which geometrical shape is suitable for use as a shell, it must not be forgotten that geometry is only an auxiliary in the description of the shape. Shells are constructional shapes and not models of geometrical forms! When a project is embarked upon therefore, there can be no question of wishing to build a dome or a hyperbolic parabola. The first element must be a specific idea relating to space and design and the question is to find the constructive means suitable for the realization of this idea in the form of a building. If it should be that a shell construction is the suitable means, then the question has to be raised as to the play of forces that condition the shape of the shell. The final design can then in the end be grasped and represented by means of geometry. Here factors have been sundered for theoretical purposes that would naturally emerge simultaneously when making out the project. It seemed necessary, however, to make these thoughts public to clarify the sequence of the individual factors: a design grows out of a spatial image; it fulfils definite functions; it is realized according to constructive norms and represented with the aid of geometrical methods.

Many of the shells being built at the present time are monuments to shell construction. They completely fail to come to grips with their function, which is to be a means in the service of a creative idea. Numerous churches recently, for example, give evidence of being extraordinarily daring constructions but there is often a lack of any congruence between the liturgy and the spatial form emerging from the method of construction.

It would be utterly erroneous, as a result of this criticism, to demand ornamentation of the construction so as to achieve a supplementary congruence between content and form. Such an attempt would fail in every respect to tackle the problem.

The shell is the most striking form of construction used in architecture. Only a design which is an expression of the flow of forces can claim to be valid. It is the function of the architect to select from the great range there is in shell constructions those which are suitable for the assignment he is faced with. It is only in this way that there is any possibility of achieving that identity of space, design, function and construction which is one of the leading criteria of modern architecture. The danger of confusing means and end is greater in the case of shells than in any other form of construction for the logic of the constructive norms and the richness there is of plastic shapes can lead even a critical mind to think of a part as being already the whole. Only by considering what significance construction has in modern architecture can an over-estimation of the constructional relationships be avoided.

But misunderstanding can arise from the incorrect estimation of the significance of the construction as well as from its overvaluation. In many instances the construction is regarded as the rationale of architecture without further ado because of certain nineteenth century theories. The steadfastness of a building can be taken for granted—this is the argument propounded by the representatives of this theory—art begins after the application of constructional principles. In opposition to this we must bring to mind once again the simple fact that any development of a certain construction which is suitable for a specific role is in itself a creative act, which is something that can have no rational foundation. What can be handled rationally is the ascertainment of the stresses and strains and their measurement. But the elaboration of the construction arising from knowledge about the play of forces is once again a form of creative activity and cannot be grasped with the reason.

The danger of emancipating the means as well as of interpreting them incorrectly can be avoided only if insight into the construction is based on profound knowledge. It is only by mastering the construction that one is able to produce truly creative design in shell constructions. There are a number of aids the architect can make use of to penetrate more profoundly into the realm of shell construction. What he needs to be able to design is knowledge about the play of forces. There is no doubt that close cooperation with the engineer can be fruitful. But there are only very few engineers who in their training and personal development are able to understand what the architect is striving for. The architect is very often thrown back on his own resources in his attempt to evolve new forms to set beside the well-known prototypes. For this reason there is nothing left for him to do than to develop methods himself which will prove informative as to the possibilities there are of new types of constructions. One of these methods is that of using experimental models. Research models correspond to the thought processes of the architect in their visual openness. At this point Antonio Gaudi (Bauen + Wohnen 5/1960) should be remembered, for he gained information about the construction of complicated vaults by way of wire models.

It is possible to think of similar lines in shell construction. The architecture of Gaudi, however, is a clear indication that such methodical work and creative imagination are not mutually exclusive but that to the contrary the imagination can be rekindled by investigation of this nature. Model research, however, is necessary for another reason. Shell constructions with doubly curved surfaces often elude representation and clarification in drawings. Only models are suitable for informing the architect as to the spatial effect of the shape he is endeavouring to achieve.

Eduardo Torroja

Experimental Building on the Site of the Instituto Técnico de la Construcción y del Cemento, Costillares

(pages 407—408)

The building in question is a research project concerned with organic form and construction and it shows certain affinities with the principles of Hugo Häring. The work as a whole is built up from prefabricated pre-stressed elements. The experimental shell is only 3 cm. thick.

In the present case an underground water reservoir had to be covered with a concrete shell. The structure as a whole is composed of six prefabricated elements.

Wilhelm Fuchssteiner and Hermann Tuch

Darmstadt Technical Supervisory Service

(page 409)

An extremely interesting structure with a doubly curved shell, the generatrix of the surface being a straight line.

Felix Candela and Joaquin Alvarez Ordóñez

Tourist Restaurant at Xochimilco

(pages 410—411)

This restaurant is set in a magnificent garden and consists of eight similar elements. Each element is a section of a hyperbolic parabola.

René Sarger, L. Simon and M. Morisseau

Royan Wholesale Foodstuffs Market

(pages 412—413)

Here we find once again the principle of a shell in concrete but unlike the case at Xochimilco there is no question here of a translation surface. The shape of the structure "moves" inwards instead of—as at Xochimilco—opening out towards the world outside.

Richard Bradshaw, Wimberley and Cook

Windward City Shopping Center at Kaneohe, Hawaii

(pages 414—416)

This has a square plan (each side 39.01 m.) with a single roof, the structure being set on four supports (double torus). Expansion due to temperature changes has been measured and found to correspond to the architects' calculations.

Felix Candela and Enrique de la Mora y Palomar

San José Obrero Church at Monterrey, Mexico

(pages 417—419)

The building in question is a further example of a structure incorporating hyperbolic parabolas supported in position by cables. The work as a whole is extremely daring and has been well handled in point of view of its construction. Unfortunately design and function do not harmonize well.

Alejandro Zohn

Guadalajara Wholesale Foodstuffs Market, Mexico

(pages 420—421)

Here we find the principle of the hyperbolic parabola once again. The plan and construction will repay very careful study.

Philipp Holzmann AG, Alfred Mehmel, Georg Petry, Otto Apel, Hannsgeorg Beckert and Rudolf Jäger

Lufthansa Service Shed, Frankfurt

(pages 422—424)

As is the case with several other similar instances, this building projects on two sides. At the beginning it was intended to carry out the building in steel as is customary with this type of structure, but then it was decided that a concrete shell should be employed.

Paul Weidlinger, Mario Salvadori and Victor Christ-Janer

Supermarket at New Canaan, Connecticut

(page 425)

These buildings have been covered by a number of concrete shells which appear to be translation surfaces.

Pier Luigi Nervi and M. Piacentini

Palazzo dello Sport, Rome

(pages 426—427)

(See No. 9/60). Here, too, a number of prefabricated elements constitute an extremely interesting shell, which is well worth studying.

Wilhelm J. Silberkuhl

Prefabricated Shell Elements

(pages 428—430)

The "h. p. shells" of the Silberkuhl system are prefabricated and can be supplied in different shapes. Once assembled they form a hyperbolic parabola.

Horacio Caminos, Atilio Gallo and Giuseppe Guarnieri

Experimental Models of Shells

(page 431)

The experiments carried out by Caminos, Gallo and Guarnieri are extremely interesting and deserve study by engineers and architects. In effect, the surfaces occur in two forms: "skins" (tents, etc.) and shells (a rigid "skin").

Frei Otto

Experimental Models of Shells

(page 432)

Among the research workers making use of models mention must be made of Frei Otto, whose work and methods repay the most thorough scrutiny.

Skidmore, Owings and Merrill

DC8 Hangars in San Francisco

(pages 435—438)

Since the construction of the famous hangar at Orly, the dimensions of planes have considerably increased. A DC8 has a length of 45 m., a wing-span of 42 m. and a height of 13 m.! The plane weighs 150 tons. If one takes into account such dimensions, it can be said that the problems involved in such hangars are very difficult ones. The structural principles illustrated in this issue show that the hangars in question can be extended as need arises without any particular difficulty.

Curt Siegel and Rudolf Wonneberg

Administrative Centre in Mannheim

(pages 439—444)

Before going on to the planning of the building itself, the architects made a careful study of the internal lay-out. Other organization studies showed that a conventional office arrangement would be out of the question. The optimum solution consists of one single large office area itself alone capable of accommodating 400 persons. As the site is not sufficient to bear a room of such dimensions, the architects succeeded in distributing the entire complex over two floors while maintaining the conception of a "hall". The total area of these two floors comes to 2,843 sq. meters. The entrance, the service rooms (WC, installations, etc.) and stairways are fixed. All the other utility surfaces are absolutely free, the furniture can be installed as needs arise.

The supporting elements are made up of a steel skeleton and the ceilings are composed of prefab cellular concrete elements. The rigidity of the whole is guaranteed by the solid anchor points of the service rooms. An office hall conception is clearly possible only if it includes all the amenities permitting such a conception: air-conditioning, acoustic conditions, etc. Heat losses, which are considerable in buildings with only parapets and windows, are compensated by an ingenious heating system which functions only at night. The air-conditioning proper works only in the daytime. The problem of acoustic insulation clearly is a preponderant one in an office building without solid partitions. Windows, partitions at anchor points and ceiling ought to be able to absorb the noise, this also applying to the floor. Daylight is assured by glassed areas on the one hand (marginal utility surfaces) and by a vast central roof which is glassed (central utility surfaces). The artificial illumination also merits our full attention: each working place ought to be sufficiently lighted without disturbing the lighting of the neighbouring places, this being a sine qua non with the "hall" conception. Finally, mention should also be made of the anti-fire insulation, which is remarkably well done in this high-quality office building.

The "hall" conception proves that it is possible to assemble a considerable number of persons in one and the same room, without any particular inconvenience; on the contrary, this conception simplifies and improves things.

Schalenbau

Die Beiträge zum Problem des Schalenbaus sind von Dr. Jürgen Joedicke zusammengestellt und kommentiert. Der Verfasser bereitet ein grundlegendes Werk über »Schalenbauten, ihre Konstruktion und Gestaltung« vor, das demnächst als 2. Band in der Reihe »Dokumente der Modernen Architektur« beim Verlag Dr. Girsberger, Zürich, erscheinen wird.

Biografische Notizen

Felix Candela
Geboren 1910 in Madrid. Studium als Architekt der Escuela Superior de Arquitectura in Madrid. Seit 1939 in Mexiko. Leiter der Cubiertas ALA. S.A., einer Firma für Schalenkonstruktionen. Goldmedaille des englischen Instituts für Bauingenieure 1961, Preis August Perret der UIA 1961.

René Sarger
Geboren 1917 in Paris. Studium als Architekt an der Ecole Spéciale d'Architecture. Leiter des Cabinet d'Etudes Techniques d'Architectures et de Construction (C.E.T.A.C.).

Wichtigste Bauten:
Eglise Notre-Dame in Royan
Basilika Sacré-Cœur de Jésus in Algier
Markthalle in Royan
Kulturzentrum der Stadt Le Havre
Französischer Pavillon an der Weltausstellung in Brüssel
Restaurant Marie-Thumas

Richard Rotherwood Bradshaw
Geboren 1916 in Philadelphia. Studium als Bauingenieur am California Institute of Technology und an der Universität von Südkalifornien. Eigenes Büro seit 1946.

Alejandro Zohn
Geboren 1930 in Wien. Studium als Ingenieur (1948-53) und als Architekt (1950-55) an der Universität Guadalajara, Mexiko. Büro in Guadalajara. Professor an der Universität Guadalajara.

Alfred Mehmel
Geboren 1896 in Köln. Bauingenieur-Studium an der Technischen Hochschule Darmstadt. Seit 1939 Professor an der Technischen Hochschule Darmstadt. Mehmel hat großen Anteil an der Entwicklung der Schalenbauweise. In jüngster Zeit beschäftigt er sich mit der Klärung grundlegender Fragen der Zylinderschalen.

Georg Petry
Geboren 1890 in Wixhausen/Darmstadt. Bauingenieur-Studium an der Technischen Hochschule Darmstadt. Praktikant als Zimmermann. Eigenes Büro seit 1945.

Otto Apel
Geboren 1906 in Berlin. Studium an der Baugewerbeschule und an der Akademie für Künste in Berlin 1926—1930. Eigenes Büro seit 1948.

Wichtigste Bauten
zusammen mit Sep Ruf, Letocha, Rohrer und Herdt:
Wohnsiedlungen in Bonn-Tannenbusch und Bad Godesberg 1951
Bürogebäude in Mehlem bei Bad Godesberg 1951
Wohnsiedlung mit Schule, Kindergarten, Klubhaus und Hallenbad in Bad Godesberg 1951;
zusammen mit Skidmore, Owings und Merrill:
Amerikanische Konsulatsgebäude in Bremen 1953, Düsseldorf 1954, Frankfurt 1954—55, Stuttgart 1954—55
Wohnsiedlung in Bremen 1953;
zusammen mit Eberhard Brandel:
Wohn- und Geschäftshäuser in Frankfurt 1954 und 1955
Börse in Frankfurt 1956—58;
zusammen mit Hannsgeorg Beckert:
Theater in Frankfurt im Bau
Wartungshalle für Düsenflugzeuge, Flugzeughalle, Borddienstgebäude, Bürogebäude, Heizzentrale usw. in Frankfurt 1958—60
Krankenhaus Nordwest Frankfurt 1959
Krankenhaus in Frankfurt 1960
Haus der Elektrotechnik in Frankfurt 1959—61
Volksschule in Frankfurt 1959—61
Hotel in Frankfurt 1960
Hallenbad in Mainz 1960
Deutsche Bundesbank in Frankfurt 1961

Hansgeorg Beckert
Geboren 1927 in Lichtenstein (Sachsen). Architekturstudium an der Technischen Hochschule Karlsruhe 1947—51. 1951—60 freier Mitarbeiter bei Otto Apel, seit 1961 Partner von Otto Apel.

Paul Weidlinger
Studium als Bauingenieur an der ETH Zürich, Abschluß 1936. Professor für Stahlbetonbau an der St.-Andrews-Universität, Bolivien, 1939—43. Oberingenieur bei der Atlas Aircraft Products, Inc., New York, 1944—46.

Publikation:
Aluminium in Modern Architecture, Bd. 2

Mario G. Salvadori
Studium als Bauingenieur an der Universität Rom. Dr.-Ing. 1930, Dr. phil. (Mathematik) 1933.
Professor an der Columbia-Universität in New York. Delegierter der USA in der Industrial Assembles of the Union of Technical and Applied Mechanics 1948-52.

Publikationen:
Werke über angewandte Mathematik auf dem Gebiet des Bauingenieurwesens.

Wilhelm Silberkuhl
Geboren 1912 in Castrop. Studium als Architekt an der Technischen Hochschule Hannover. Eigenes Büro in Essen.

Wichtigste Bauten:

Industriebauten für	
Porsche in Friedrichshafen	1955—56
Keller + Knappich in Augsburg	1958—59
Ford in Köln	1960—61

Horacio Caminos
Geboren 1914 in Buenos Aires. Professor für Architektur und Stadtbau an der Universität Tucuman, Argentinien. Professor für Architektur am North Carolina State College in Raleigh, USA. Studien für billiges Bauen, Membran-Konstruktionen und weitgespannte Konstruktionen.

Frei Otto
Geboren 1925. Studium an der Technischen Universität Berlin; Promotion zum Dr.-Ing. Eigenes Büro seit 1952. Studienarbeiten über anpassungsfähiges Bauen und über hängende und gespannte Konstruktionen.

Curt Siegel
Geboren 1911 in Brüssel. Architekturstudium in Dresden; Teilstudium als Bauingenieur. Praxis als Statiker. Eigenes Büro seit 1946. Professor für Statik an der Hochschule für Baukunst und Bildende Künste in Weimar 1946—50 und an der Technischen Hochschule Stuttgart seit 1950.

Publikation:
Strukturformen der Modernen Architektur 1960

Wichtigste Bauten:
Perlonfabrik in Schwarza (Saale) 1948—49
Kollegiengebäude der Technischen Hochschule Stuttgart (zusammen mit den Professoren Gutbier und Wilhelm) 1957—60;
zusammen mit Rudolf Wonneberg:
Emaillierwerk und Haushaltgerätefabrik in Bretten (Baden) 1955—57
Institut für Physik der Strahlantriebe in Stuttgart 1959—61
Chemische Fabrik in Offenburg 1960—61
Verwaltungsgebäude in Mannheim 1959-60
Gießereihallen in Lohr 1959—61
Institut für Statik und Dynamik der Flugkonstruktionen in Stuttgart 1961

Rudolf Wonneberg
Geboren 1922 in Teuplitz. Studium an der Hochschule für Baukunst und Bildende Künste in Weimar. Eigenes Büro in Stuttgart zusammen mit Curt Siegel seit 1956.

Hermann Tuch
Geboren 1901 in Darmstadt. Studium an der Technischen Hochschule Darmstadt. 1929 bis 1945 Regierungsbaumeister bei der Preußischen Staatshochbauverwaltung Berlin. Seit 1952 Vorstand des Staatsbauamtes Darmstadt. Seit 1955 Regierungsbaudirektor.

Wichtigste Bauten der letzten Jahre:
Wiederaufbau von Schloß und Museum Darmstadt
Technisches Überwachungsamt Darmstadt
Radarturm auf der Neunkircher Höhe im Odenwald
Staatsbauschule und Ingenieurschule in Darmstadt

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