Concrete in contemporary architecture

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Le béton dans l'architecture contemporaine

Beton und zeitgenössische Architektur

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SUMMARY
After introductory considerations on the evolution of architectural trends and on the controversial evaluation of contemporary achievements, the author debates the meaning and architectural personality of concrete, the only material capable of fulfilling the most dreamed of aspirations of architects for space handling. Some examples of significant Italian constructions where the expressive power of concrete is enhanced, are illustrated.

RÉSUMÉ
Après une introduction sur l'évolution de l'architecture moderne et sur la controverse des réalisations contemporaines, l'auteur disserte sur la personnalité et l'expression créative du béton, le seul matériau capable de satisfaire les aspirations les plus poignantes des architectes en ce qui concerne l'expression spatiale. Des exemples de réalisations italiennes illustrent les possibilités d'expression du béton.

ZUSAMMENFASSUNG
Nach einführenden Betrachtungen über die Evolution der modernen Architektur und die kontroverse Akzeptanz zeitgenössischer Bauwerke werden die Bedeutung und die architektonische Ausdrucksweise des Betons erörtert. Der Beton ist das einzige Rohmaterial, das dem Architekten die höchsten Wünsche betreffend die räumliche Gestaltung erfüllt. Einige Beispiele italienischer Bauwerke veranschaulichen die Ausdrucksmöglichkeiten des Betons.

1 - INTRODUCTION

To evaluate the meaning of a building material - concrete in our case - in the Architectural world, we can not avoid a few considerations on the uneasy, controversial life of modern Architecture.
"All sensible and sensitive people - says the writer Paul Johnson - know that "moderne architecture is bad and horrible.
On the other hand another Johnson, the famous american architect Philip Johnson still creative at 80, taking a telescopic view of present trends within an historical perspective, considers moderne Architecture "extremely rich and exciting"
Statements like these prove - to my opinion at least - that we are living one of the most creative and controversial periods in architectural history. Never we had such a great public interest in - and hostility to - what has been built in recent years - and that for sure means the great vitality of modern architecture.
We realise how true are the words written by Artur Koestler in his fine book "The act of creation".
"The act of discovery has a destructive and constructive aspect:it must disrupt "rigid patterns of mental organisation to achieve the new syntesis. Only by "escaping the popular frames of reference and critically examining conventional "methods and techniques can new ideas be developed and implemented.
"Desorder appears to be a necessary part of the creative sequence and uncer- "tainty goes with it.
Which is then the genesis of such desorder and uncertainty?
To answer this question, we may usefully turn to two fundamental moments in the history of architecture. The first of these came when the Renaissance accorded recognition to the analogy between chords appreciable by the ear and proportions by the eye, thus setting the seal on the entry of architecture into the universe of numbers erected by the Pythagoreans to bear witness to their faith in the harmonic and mathematical structure of the whole of creation.
According to an unbroken tradition stretching back to antiquity itself, arithmetic, geometry, astronomy and music constituted the quadrivium of the "mathematical" or "liberal" arts.
Painting, sculpture and architecture were, by contrast, classed as "manual" arts. Their elevation to a superior level required that they be endowed with a firm foundation, in other words a mathematical basis.
This transformation was the "great leap forward" achieved by the architects of the 15th century. It need come as no surprise that they turned to music as the only liberal art capable of answering their needs, capable, in other words, of supplying those laws of harmony, proportion, symmetry and tonality that would provide the key to the solution of their problems.
From this time onwards, therefore, the canons of harmony and the hierarchical, arithmetical and geometrical proportions that strictly governed the relations between lines, areas and volumes became the benchmarks for every work of architecture. It was unconceivable that there could be any other world of architectural composition other than that of harmony.
The second of these fundamental moments of history occurred during the 19th

century, when the concepts of harmony and proportion succumbed to a shattering revolution. On the one hand, changes in mathematical thought demolished reference to Euclidean geometry as the only geometry possible, thus unmasking a world of possible alternatives. On the other hand, a cultural revolution of enormous compass conferred artistic citizenship on all forms of expression that lay outside the pale of harmony, symmetry and proportion, thus sanctioning the total uncoupling of the liberal arts from their erstwhile mathematical foundations.
The whole structure of classical aesthetics was systematically upheaved. It was not by chance that atonal and dodecaphonic music were accompanied by the appearance of cubist and abstract painting and sculpture. Architecture, too, was completely freed from the restraints imposed by the mathematical relationships of formal harmonies, from coherence and the recurrence of expressive themes.
The birth-pangs of this evolution are with us yet. A hardship compounded by the absence of limits and "rules of the game", so that the way lies open to tremendous risks and brazen speculations that are particularly dangerous in the domain of architecture.
Yet it is one we must accept and learn to live with.

2 - CONCRETE AND ARCHITECTURE

What place can be assigned to building in reinforced concrete in this picture of a changing, mutating architecture?
It came on the scene when the fragmentation of harmony was already in progress, albeit it at the embryo stage.
The great unease that moved artistic sensibilities immediately divined that a material capable of satistying architecture's most recondite aspiration now lay ready to hand.
The opportunities reinforced concrete offered of defining both interior and exterior spaces and volumes, whether concluded or continuous, were first appreciated by poets and artists. As "Paul Claudel put it: ... L'Architecture cesse "d'être enfermée dans sa prison cubique... ...le ciment armé n'est pas un mate- "riau rigide, c'est un tissu souple, un epais feutre, de la matière coulante. "Il est a estamper d'un seul coup de l'imagination...
The totally different personality displayed by this new material when compared with stone, wood and iron was immediately apparent: the possibility of expression in plates or bulks, linked to or free from geometrical references and rich in a new fundamental connotation, that of a continuity of expression and modelling unthinkable before; the possibility of forming space anew, as Riegl was later to declare ..."A mature vision which extols space: in the beginning, "static and cubic space, then fluid, dynamic, formless space emancipated from "geometric constraint".
Later, however, the exciting connotations that emerged during the infancy of reinforced concrete became cloudy and lost their substance: economic reasons, production logics and poor scientific support shattered the manigificent continuity in flat, linear members - beams, columns, slabs - conceived by analogy with typical building elements in wood and iron.
This magnificent continuity, along with the high charge of architectural expressiveness inherent in the new material, remained a latent feature. At the begin-

ning of this century and in the Twenties, they appeared yet, in works with a strong structural personality.

It was, indeed, the masterpieces of the great pioneer, Maillart, followed by Edoardo Torroja and Pier Luigi Nervi, that opened the way to that structural expressionism, soon to become a mighty architectural patrimony.
So much has been written about these masters that any further comment might appear superfluous. Since my paper is particularly directed to Italian achievements, however, I would ask to be allowed to say a little more about Nervi.
In addition to being a designer, he was a building contractor, of necessity constrained by the iron laws of competition and the economic running of a business.
Yet he succeeded in extracting from these constraints the inspiration for a highly personal architectural interpretation of concrete that connotates the constructional features of his structural inventions.
In his works, indeed, the static stance of the whole is purposely simple and - in general - decidedly classical, obedient to the laws of harmony and symmetry. The whole of his invention lies in a parting of the structures into a sapient play of prefabricated parts, subsequently assembled on the site into a scheme capable of recreating a faultless continuity in a framework of luminous logic (fig. 1).
It was perhaps this two-sidedness of Nervi's personality, his blending of the designer and the building contractor, that deprived him of disciples. Ho thus remains and will continue to remain an unique figure in the history of structural architecture.

3 - EXAMPLES OF ITALIAN ACHIEVEMENTS

Another figure of great import in the field now being examined is the Italian engineer, Riccardo Morandi, who always managed to express in his very many works the architectural force inherent in creations of great structural distinction.
Unlike those of Nervi, his works are always marked by a desire for structural invention capable of throwing into elegant architectural relief a static equilibrium that plays the leading role, underscored both by the shape of the members and sections and by the presence of nodes, supports and hinges whose interpretation is not open to doubt.
In addition to this strictness of expression of his, Morandi will be remembered as the man whose greater courage overcome the limitations inherent in the nature of reinforced concrete since he invaded the field of structural shapes from which concrete itself was physiologically barred, extracting from it fully independent architectural motifs.
The hangars at Fiumicino (fig. 2) offer an example of a reinforced concrete hanging roof. By exploiting prestressing in a highly personal manner, Morandi has succeeded in giving an impeccable picture of the equilibrium of the forces involved, though with an architectural expression totally different from that which would have emerged had he used simple steel cables instead of concrete stays.
Another interesting example of the special architectural effects that can be obtained thanks to the use of prestressing is offered by Morandi in the FATA

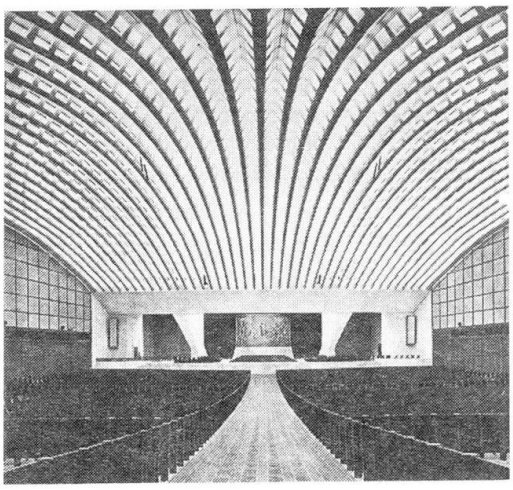

Fig.1 Roma - Vaticano Audience Hall Design and Construction: P.L.Nervi

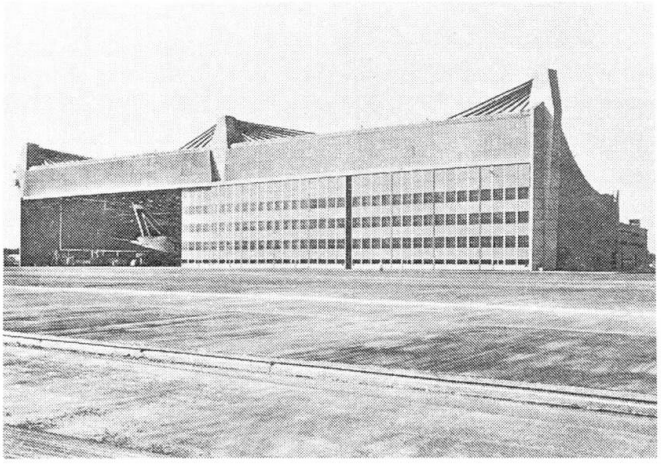

Fig.2 Roma - Fiumicino Airport Hangar Design: R. Morandi

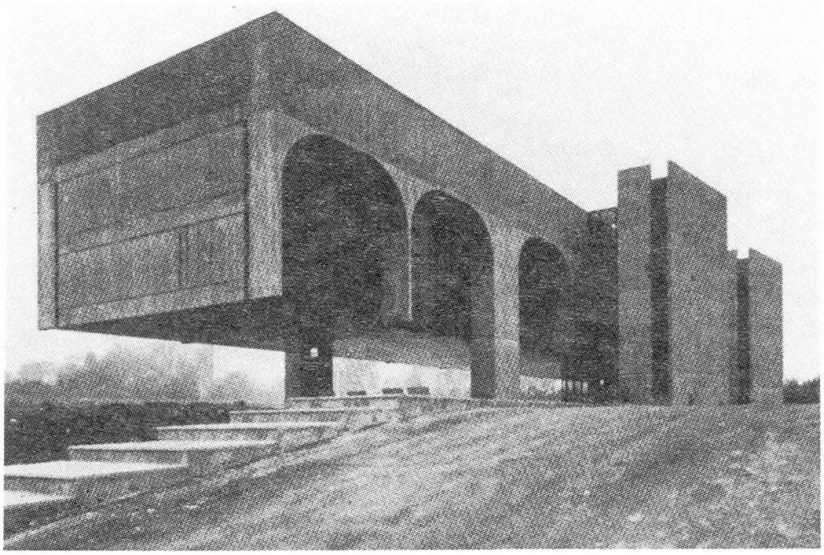

Fig.3 Torino - F.A.T.A Offices Building Design: O. Niemeyer - R. Morandi

office building, Turin (architect: O. Niemeyer). The formula adopted to bring out the presence of the stays in ideal reference to the column-arch layout, makes it one of the most unusual and elegant example of a suspended-floor building (fig. 3).
In effect, we can realise that today's concrete architecture has rediscovered and put to their best use those characteristics of the material that had been sensed from its earliest days: the possibility of breaking out of the "cubic prison" and forming continuous, dynamic spaces with multiply curved three-dimen sional surfaces, closed, pierced or even gaping: the possibility of splitting spaces, whether modularly or irregularly, with assortments of flat slabs rendered continuous thanks to geometrical repetitions or free patterns: and the possibility of exalting the power conferred by the mass of this material, sprea ding it and shaping it in ways sometimes deliberately cumbersome and so devoid of all harmony as to even appear a contradiction of the logic of static flows.
The picture is one of a new freedom, a territory awaiting exploration, where speculation and the most anomalous fancies may flourish. This is even more true now that computerised procedures have eliminated nearly all the difficulties posed by analytical investigation, while new materials and new techniques make it possible to mould this "cast stone" into shapes that would have been unthinkabel only a few years ago.
The moment is thus a weighty onde, pregnant with the weighty responsibility that lies on reinforced concrete architecture, which is called upon to discipli ne this abundance of freedom.
At this point, it may be of interest to see what is happening in a sector peculiar to reinforced concrete, namely that of shell structures.

Shell structures are surfaces whose strength lies in their form, and those best capable of fulfilling Claudel's prophecy.
They aroused considerasble interest in the engineering and design world when Maillart first stressed the possibility of confiding the task of providing strength not to cross-section mass, but to the global shape of suitably curved thin plates.
Architecture became aware that it was presented with an extraordinary chance of finally creating that "fluid, formless space emancipated from geometric constraint" imagined by Riegl at the beginning of the century.
Much creative effort was devoted to this sector, many, indeed, were the sound results obtained. Yet, in the long term, one fact became evident. Reference to a set geometric shape or "constraint", inevitable for calculation and construction purpose, slowly but inexorably suffocated the exceptional architectural force inherent in shell structures. Works of great architectural significance could not appear until some way was found of breaking free from this constraint.
In this connection, the last ten years have provided instances of great worth, partly thanks to sugestions stemming from the sphere of hanging roofs (albeit no more than partly applicable to shell structures) and from surfaces with a minimal spatial development between given borders. It has thus proved possible to head towards notions of new shapes and outlines statically more economical for the edge members, though difficult to fit within geometrically established surfaces and curves.
Italy has offered a magnificent example of the interpretation of these notions

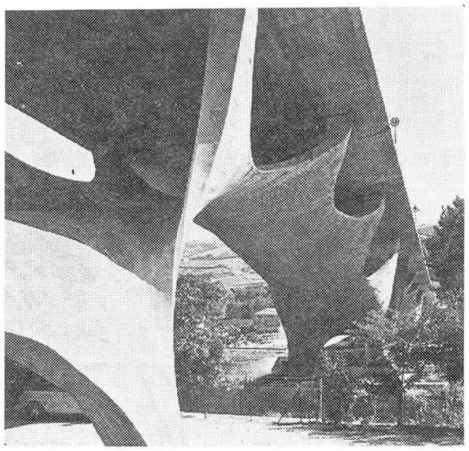

Fig.4 Potenza - Shell bridge over Basento River Design: S. Musmeci

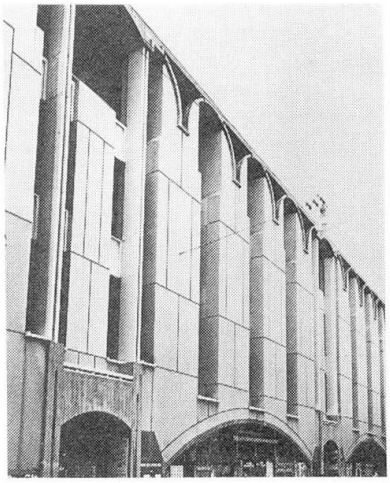

Fig. 5 Padova - Bank of Italy Building
Design: G. Samonà - G. Pizzetti - A. Chiorino

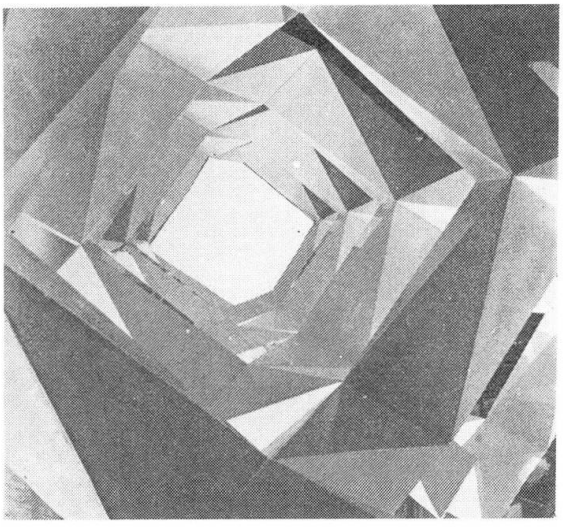

Fig.6 Roma - Space Structure (Exhibition Model) Design: S. Musmeci

in the shell bridge designed and built by Prof. Musmeci over the River Basento (fig; 4).
This consists of four 70-metre bays, each formed of a 30 cm thick plate, shaped in accordance with multiple-curved surfaces, either positive or negative depending on the static reference pattern,and designed so as to achieve pure longitudinal and transverse compression stress conditions, without edge disturbances.
The static flows are conveyed to the curved plate and then discharged to the ground thanks to zones of support for the runway, and zones of support on foundations obtained by piercing the plate. The effect is to define truly unique inner and outer continuous curved spaces that blend in perfectly with the landscape.In the other building sectors, the panorama of Italian accomplishments in reinforced concrete in recent years is both extensive and varied, rich in works of undeniable architectural personality, yet also burdened by much capricious ballast. A balance cannot be drawn, nor even a reasoned recognition be offered, owing to the limits placed on this paper.
All the same I remember, as an example of using concrete in a well balanced blending of structural elements and decorative motifs, the Bankitalia building in Padua (fig. 5).

To close, I would like to observe how the new-born "special concretes" (hyperplastified, polymerized) can enriche and enhance the possibilities of architectural expressions of reinforced concrete,thanks to their high strenght and fine elastic behaviour.
Polymerized, or synthetic resin impregnated concrete for instance (strenght up to 130-140 N/mm^2), opens a world of new forms and shapes both in shell structures as in space frames.
As far the last are concerned, we could think in terms of space lattices according geometric patterns quite new as to the structures typical of the architecture of steel.
Fig. 6 shows a space structure of this kind, in polymerized concrete,with rigid tetrahedral nodes studied and presented by Prof. Musmeci at the "Week of Architecture" in Roma (1979).
A new world to explore, a safe guarantee of riches and vitality in concrete Architecture for the years to come.