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New Orders

In search of a new point-block diagram for Hong Kong

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***Abstract*— A series of alternative structures for housing are proposed through a design-research prototyping process. Nine proto-structures are developed through the conception and realization of columns cast in concrete. The series explores specific structural principles at 1to1 scale, which are further architecturally tested as speculative towers for urban living at 1to100 scale.**
At 1 to 1 scale, concrete as process rather than just concrete as material sets the main methodology for the design-research. Trial and error experiments, closely related to the properties of the material (liquid to solid formation), seek to put forward new techniques of formwork design and construction procedures that are more flexible and more sustainable than past and current systems.
Design analysis, informed by the work of the early 'structural rationalists' (F. Candela, P.L. Nervi, H. Isler, R. Maillard, E. Dieste, et al.), considers the transformation of structural languages in an attempt to revive an architecture for vertical living (point-block).

Keywords- Point-block towers, reinforced concrete, formwork design, structural system, Housing speculations

I. INTRODUCTION

A. Historical Background

The modernist search for concrete-based new models for living, fuelled by an urgent need for cheap housing after the world war destruction, was devised in Western Europe in the form of a cast-in-place skeleton frame. In the late 19th century, this flexible column-slab system was first patented and distributed by the 'Hennebique' enterprise, supported globally by his licensed agents and concessionary contractors [1]. His focus on reinforced concrete structure prompted the initial schism between architectural design and technical construction.

In 1914, Le Corbusier generalized a two-storey column slab structure, known as the Dom-ino protocol (domus-innovation). Its promise was social; to support individualization of living spaces by internally liberating the plan of a building from its structural imperatives (Free Plan).

This mass-produced and standardized construction method provided its future inhabitants with a plain and low-cost framework to be further individualized based on means, aspirations and identity. What the Dom-ino model essentially offered, by highlighting the slab, was the idea of an empty plan; a new ground, released from the literal one [2]. This quickly projected the possibility of envisioning a multiplicity of 'free' grounds (as slabs) whose sequence of spatial organizations would not need to be identical anymore (homogeneity vs. repetition of differences): A clear concept that has struggled to this day to fulfill its early assignment.

On the contrary, the structural ideal largely continues to overshadow its architectural benefits, caused by a preoccupation for high efficiency, great economy of means and for the small labor skills it demands (DIY).

A century later, this now ubiquitous structural system has largely achieved the reverse: mainly creating an order characterized by homogeneity based on the repetition of the same living units across many building scales.

However, the advent of structural reinforced concrete originated long before Le Corbusier's 1914 icon.

Much needed experimentation had taken place over half a century prior to any practical and theoretical formulations. Architects and engineers were the last and least advocates of the potential for this new hybrid (concrete and steel) and continuous material. Many of the physical undertakings, conducted around 1850, through successive trial and error efforts at full scale, were just carried out by builders and contractors (i.e. J. Monier, F. Coignet, J. Lambot, et al.) in their backwards [3].

It was only after various inaugurations of proven patents (F. Hennebique, R. Maillart, et al.) in international fairs that architects, such as Auguste Perret (for whom Corbusier used to be a young apprentice), started to sympathize with the 'modern' material.

In pursuit of greater structural and material honesty, A. Perret and his brothers, not only dared to incorporate the skeleton frame in their (self-) built projects, but highly contrasted it against some of the more classical features dominating their architecture. 1904 saw one of the first detachments between (concrete) structure and infill in architecture, rationally manifested in Perret's rue Franklin apartment building in Paris [4].

B. Hong Kong point-block

For some time now, the post-slab system has been more in full service of the developer and contractor, seeking larger sale margins, than of the architect, prioritizing perhaps more spatial diversity and better living qualities. Hong Kong's built environment demonstrates vividly that assertion, where all living cells within a building entity have each been normalized at great heights, facilitated by a rudimentary cast in situ concrete frame to which standard facades and curtain walls are clipped on.

Housing complexes in this context have become condensed agglomerates of sealed units around a single core, pruned for individual living. The collective qualities that once distinguished the early experiments of the Housing Authority in Hong Kong have slowly been stripped off from buildings and at best flattened to quasi-public podia [5]. The podium-tower model, Hong Kong's dominant living type, suggests little possibility for community living, caused by a relentless repetition of the same living cells within a built complex.

Indeed, integrated public spaces (i.e. courtyards, elevated streets as extensions of living spaces), outdoor living at the unit scale, shared functions, amenity spaces, public grounds and urban connectors, all which stimulate social interaction in housing, are nowadays scarce encounters in residential projects in Hong Kong.

The proposed design-research aims to develop new structural articulations for high-rises that are more agile in transiting from one type of program to another within a complex. These aim to provide residents with gradients of communal spaces that reconcile (semi-) outdoor living issues in a sub-tropical climate.

C. The Structural rationlists

If one considers concrete as process and not just concrete as material, all that has been presented above, might appear not so Modern, after all. Reminiscent of timber structures used in construction previously, these 'new' reinforced concrete systems do not capitalize enough on the properties of the material; a liquid and continuous agent. For the most part, they have more efficiently repeated formerly known structural systems with a new material. Instead of being restricted to an amalgam of predefined rigid elements (post, beam and slab, more suitable for timber and steel), greater design investments in formwork methods might greatly contribute to the quest for new volumetric continuity and for different spatial organizations, beyond efficiency and practicality. In this respect, technology and innovation must be less concerned with the material's imperatives per-say but rather strive to emulate the range of discoveries that emerged from the early empirical methods of concrete constructions.

Only after World War Two, non-conformists came to reconsider the full potential that reinforced concrete suggested at its origin. Sometimes called the structural (hyper) rationalists, personalities like Torroja, Nervi, Candela, Isler, Maillart, pushed to great effects the true premises of the original material: a short lived *liquid* mass in space, in search of new *solid* formations.

To address this, they placed a strong emphasis on experimentation towards the development of formwork design, supported by well-articulated geometries and methods of construction that will liberate concrete again from an all too safe and predicable approach (a 'Non Safety Factor' approach). Yet, the restored attitude towards structural concrete did not just come without a high level of risk taking and from time to time without failures.

While these structural mavericks took reinforced concrete to the limit of what the new material could do both structurally and spatially, their pioneering work responded, for the most part, to lower building scales and to singular programs (i.e. civic, cultural, religious); all but Housing.

The research revives the dialogue in the context of high density Asian living. The dialogue is being pursued with new technology in formwork design that breaks from the homogenizing influence of concrete and from the monotony of current systems.

II. METHODOLOGY

Figure 1. Concrete prototypes of column 1 to 7

Seven concrete prototypes are explained from conception to realization. The methods described include literature review of precedents, structural and environmental analysis, parametric design, formwork fabrication and housing speculations.

At a time when much design and fabrication emphasis is placed on surface definition, the presented methods instead concentrate on the physical description of negative volumes, for concrete casting. In some cases, projective geometries are used to rationalize intricate solids into assemblies of 2d templates, guiding an optimal 3d interpolation of the global geometry for the making of the formworks.

A. Column 1 (Shelling and Fluting)

Figure. 2a

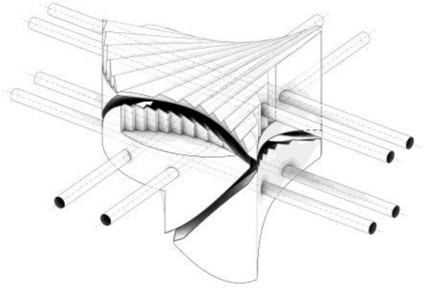

Figure. 2b

The architectural investigation for this prototype proposes a sequence of semi-public outdoor spaces within the shaft of a column through perforations while aiming for a high degree of structural integrity. To achieve this, a structural knuckle made of a maximum of air was conceived with minimum material (Fig. 2a). Column 1 draws on the history of thin shell structures, specifically by revisiting Felix Candela's work on Hyperbolic Paraboloid also known as Hypar. Warped surfaces, efficiently described by a series of rotating lines (ruled geometry) and in close proximity with its resulting formwork procedure (lines materialized by straight timber elements), serve as the principal spatial and structural element for the void description [6].

Instead of considering saddle structures as single storey, the prototype instigates their potential to stack up into a vertical compound of interchanging vaults. 4 rotating hypars of varied amplitudes interlock to describe 3 successive voids within a vertical shaft (Fig. 2b). The first tested hypar composite comprises of 87 percent of air and of 13 percent of structural mass.

Following a series of incremental formwork design and casting tests, a final 1to1 scale prototype was built to assess its loading resistance. The concrete shaft consists of three parts; a bottom support, the middle hypar composite of 12mm thick, weighting 5kgs and a top loading element of 30kgs. The ceiling planes of each of the saddle surfaces were structurally amplified by protruded ribbed beams connecting the ruled lines of the successive hypars. Those same lines were extended out as flutes along the surface of the shaft in an effort to accentuate the column's vertical reading (Fig. 2c).

Figure 2c

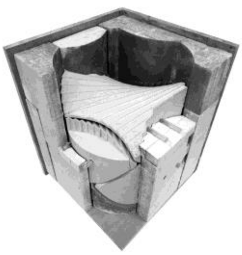

Figure 2d

Figure 2e

Upon completion, the prototype was assessed to be properly performing under dead load and deemed successful as initial proof of concept. Further analyses through computational simulations were conducted to evaluate more accurately the stresses distribution from hypar to hypar under various loading scenarios.

The fabrication of the formwork took into account the issue of formwork decentering known in thin shell structures. This was accounted for through a two-step casting process; by first producing the 3 positive voids in rubber as part of the final mould for the concrete hypar composite (Fig.2d, 2e). The rubber plugs were used for their ductile property in demoulding to prevent any concentration of stresses on the shells.

B. Column 2 (Branching and Corrugating)

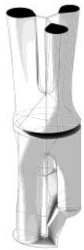

Figure 3a

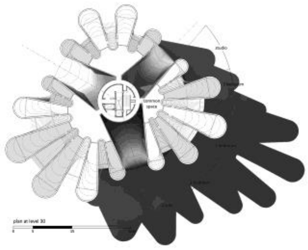

Figure 3b

Figure 3c

The primary massing task for this prototype is to create a branching column. A column whose central bulk is able to split into smaller footprints; downwards to engage with an irregular ground, upwards to maximize light penetration and air exposure to living units (Fig. 3a).

Additionally, to increase the structural performance of the splitting column, a corrugated wall is introduced. The study of Eladio Dieste's vertical ruled surfaces initiated this set of experiments. His use of conoids to amplify the surface of a wall [7] does not only inform an augmented structural resistance to the overhanging arms but also demarcate the spatial and living organization of the column. The degrees of protrusions and recesses described by the geometry of the irregular corrugated wall are the result of environmental analysis, corresponding to the level of solar radiation the column receives yearly, based on its orientation and climate (sub-tropical Hong Kong). The more the sun exposure, the greater the amplitude of the corrugation becomes to provide properly shaded inlets. Each unit type comprises of spaces both inward and outward facing, delineated by the undulation of the structural wall (Fig. 3b).

The main question became how to translate this specific geometry into material and how to synthesize an operational construction procedure through formwork design. Additionally, undercuts arises from the resulting geometry, making the removal of the formwork ever more challenging. The final strategy involved a three-step process; by first materializing the corrugated geometry as a positive (Fig. 3c), in order to cast the negative in rubber (Fig. 3d) so that the concrete cast positive can easily be released at the end of the curing process.

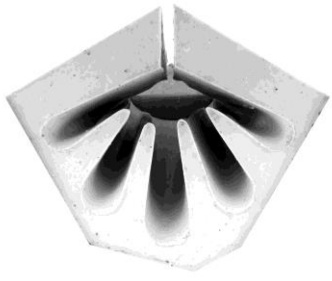

Figure 3d

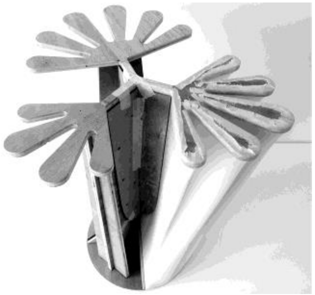

Figure 3e

The innovation in this procedure resides in the making of the first positive. By simply describing the various 2d edge profiles, a timber skeleton is fabricated onto which a sheet of geotextile is stretched to precisely interpolate the remaining 3d geometry (Fig.3e). The method employs simple means to fabricate complex geometries and is found more effective than existing cumbersome processes concerned with the making of rigid and lost formwork (plaster copy or CNC milled positives). Once properly secured onto the timber framework, the fabric is then hardened with epoxy coating, ready to be cast. Improved versions of this technique have been incrementally experimented with in the making of subsequent prototypes. The number of steps, the casting process required, remains something to improve on. Further experiments with this technique seek to eliminate the intermediary rubber casting in order to make the procedure even more expedient and economical.

C. Column 3 (Bundling and Wedging)

Columns 3 to 5 experiment with different implementations of central courtyards in tower building. The introduction of inner courtyards in high rises has not gone uncontested overtime. Not for their lack of attributes to community living, but rather for their deficiency to perform environmentally. Besides air and noise issues (void acting as resonance chamber), raising privacy concerns, the scarcity of natural light penetration during certain periods of the year poses the main challenge for this specific typology. To verify this assumption, field studies and environmental analysis were conducted on two notable 30-storey courtyard projects in Hong Kong (Lai Tak and Wah Fu estates). In summary, it was proven that for most time of the year, the lower half of these square and circular courtyards receives an insufficient amount of lighting.

Figure 4a

Figure 4b

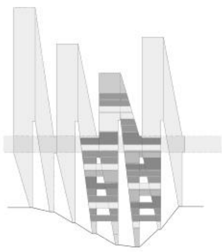

Figure 4c

Instead of defining courtyard as mass subtraction, column 3 reverses the condition by taking an additive approach towards its spatial and structural description. Four inverted V-shaped towers are proposed to delimit a central courtyard and to make-up for a larger point-block complex (Fig.4a). This bundle of slender towers, known as pencil type tower, facilitates the circulation of air and the penetration of light at grade, while retaining the bulk of the block up above (Fig. 4b). To do so, each pencil tower splits downwards into small footprints, demarking a thin and tall void space, wedged between each leg (Fig. 4c). The splintering of the column into 8 discrete footings becomes more agile in receiving a hostile ground characterized by extreme topography.

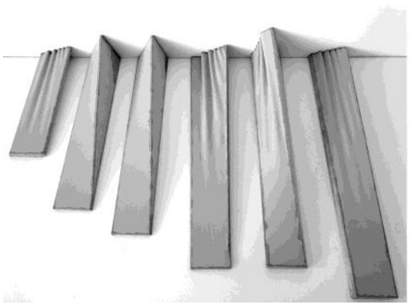

Figure 4d

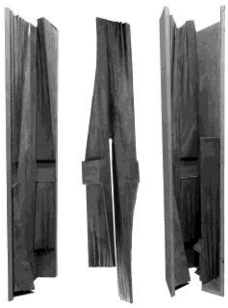

Figure 4e

The fabrication method for this prototype focuses on the making of the warped plug-ins for the spatial description of the voids (Fig. 4d). The casting procedure for each leg is a one-step process and the formwork is made of two main parts, including six plugs (Fig. 4e). The warping of the plugs allows each of the leg elements to realign radially as a whole to reach greater lateral structural stability and mass equilibrium of the column. The warping geometry is materialized by a sheet of fabric stretched over an irregular frame. After casting, the decentering of the warped plug-ins was facilitated by the fact that each plug is conceived as a wedge. Each 4 legs were cast reusing the same two-part formwork, only the plugs were replaced at each casting cycle.

D. Column 4 (Hollowing and Channeling)

The housing type under scrutiny for the making of this prototype is the semi-open courtyard block. The study of Pearl Bank Apartments (designed in 1976 by Tan Cheng Siong in Singapore) prompted the design research for this particular form of housing. The 38-storey habitable wall, surrounding an open void facing west, still stands as one of the largest slip-form structure performed today. A sequence of radiating shear walls, organized in a 270 degrees shoe-horse plan, breaks the dominance of the horizontal datum, only to reconfigure it vertically into a three-dimensional puzzle of varied townhouses in the sky [8].


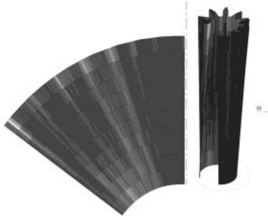
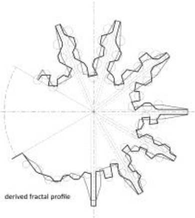

Figure 5a Figure 5b Figure 5c

The search for an alternative intramural living sets the point of departure for the prototyping of the column. A first experiment was to conceive a hollow and open column (300 deg. shoe-horse plan) whose thickness gradually changes in cross section, to support various types of living units (Fig.5a). The main housing intention is to introvert living by directing the unit types towards the central open void. While the outer surface of the column is left plain and untouched, the inner surface, in contrast is highly articulated. A full solar radiation analysis on the inner surface of the voided column guides its material, spatial and structural definition. By analyzing the solar exposure that the void receives (from top and west) over the course of one year in Hong Kong, zones of changing light intensity are mapped on its inner surface (Fig. 5b). Two fractal lines located at bottom and top profile of the column respond to the colored radiation map by recessing inside the original thickness of the column and by protruding outside of it (fig. 5c). That is, the areas showing the highest heat gain receive greater surface definition while the passive areas remain flat. This method produces a heterogeneous sequence of vertical channels, maximizing the amount of shaded spaces for living, desirable in this sub-tropical climate.
Improving from the formwork procedure of column 2, the technique created here is only one-step process and bypasses the intermediate rubber casting step, even if undercuts in the surface articulation are still present.

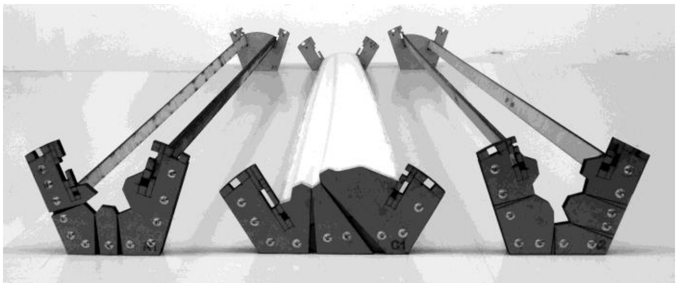

Figure 5d

To account for the issue of mould release, triangular gaps are introduced in the top and bottom hard profiles to allow movement of the corrugation when releasing the formwork (Fig.5d). Further developments of the prototype will include how to conceive a slip formwork that can be reconfigured at each climbing steps to progressively adapt to the varying channeling lines generated for the inner wall of the void.

E. Column 5 (Aggregating and Lensing)

The central void, in this last iteration on courtyard application, is generated by an aggregation of varied concrete elements. The prototyping method involves repetitive casting, reusable formwork and assembly rules from specific geometries.

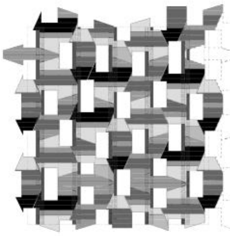
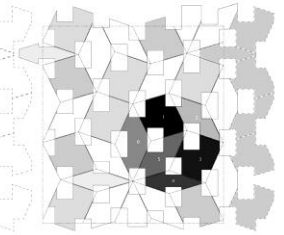
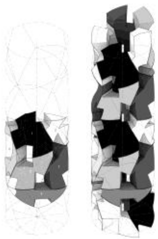

Figure 6a Figure 6b Figure 6c

For this case study, the larger inner void is disseminated into an arrangement of local voids, all puncturing the thickness of the column, for light and air intrusion. A range of different combinations from a number of modules makes each void specific and unique from its neighbors. Taxonomy of localized nodes reorganizes outdoor living around smaller vertical courtyards of varied density, in an effort to increase community living within a larger housing complex. A series of vertical circulation around the building, feed each semi-public void directly, from which their respective living clusters are then locally distributed to stimulate social encounters between residents (Fig. 6a). The organizational system for the column takes advantage of specific geometries, known as quasi-periodic tiling. Its main property is to generate long range order symmetry, instead of close repetition of same element (copy/paste). Namely, from a minimum variety of tiles, a field of maximum diversity is generated based on a set of possible combinations of few elements (Fig. 6b). From adjacency analyses, assembly rules are determined by sorting which edge of a tile can combine with which edges of other tiles [9]. The proposed column employs 6 types of concrete elements that can combine in various ways into a diverse field of 41 elements (Fig. 6c).

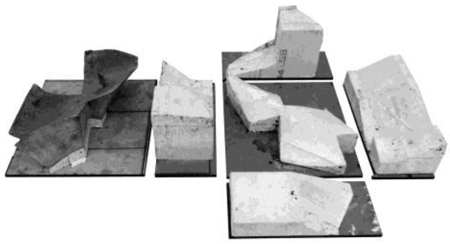
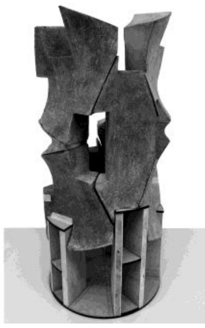

Figure 6d Figure 6e

By capitalizing on such geometrical framework, the effort placed on the consequent fabrication process is substantially reduced. Indeed, only a limited number of formworks are required to make up for a diverse field.

Mass-production and formwork reusability is the main focus for the prototyping endeavor. Six formworks are devised as 8-part moulds (1 top, 1 bottom and 4 sides) in the production of the 3-dimensional modules. The CNC parts of the EPS mould are made independent to ease the (re)assembly and dismantling of the formwork at every pouring cycle (Fig. 6d). Upon final assembly of the column prototype, it was surprisingly found that the concrete modules were supporting one another by gravity or simple friction between the tiles ‘edges without the need for extra bonding or mechanical connections (Fig. 6e). To amplify the reading of the various combinations of elements (ranging from 3 to 8 tiles) that disclose each void, the tiles external surfaces are made concave. Rather than placing emphasis on the concrete elements per say, this process of lensing strengthen the reading of the seams as the principal structural driver for the prototype.

F. Column 6 (Swelling and Shearing)

Entasis is the application of making a column conical (rather than just cylindrical) to rectify the visual perception of concavity produced by a straight shaft [10]. This technique is assumed here less for visual correction but rather to initiate a structural query. By swelling the central shaft of the column, six vertical sections demark an array of independent shear walls, some at the extremity, left free from the ground. The research begins with how to interconnect the walls into a cohesive structure while concurrently formulating an integrated organization of varied living spaces.

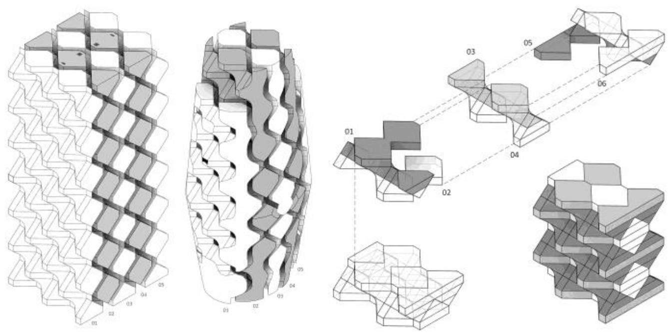

Figure 7a Figure 7b

The vertical transposition of Frei Otto’s high and low points tensile membranes, brings the potential for a field of connecting points between the different shear walls [11]. A constellation of positive and negative normals to the original planes of the walls distorts them to form bulges that bind the walls together (Fig. 7a). This set of protuberances not only provides a greater lateral resistance to the wall structure but also directs the principal organization of the living units for the project. Each unit is laid out following two main directions in space, one frontal, receptive to light, and the other transversal to increase natural ventilation across the connecting walls (Fig. 7b).

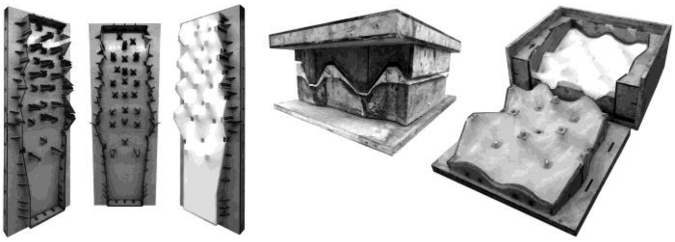

Figure 7a Figure 7b

The prototyping exercise for the making of the walls exploits the simplicity of Frei Otto’s original geometry, economically described by a set of high and low points. The three-dimensional surface derived from this set of points is efficiently achieved by interpolating a sheet of textile onto a constellation of physical vectors, bounded by edge profiles (Fig. 7c). The fabric is secured on the wooden vectors with plugin elements that later provides the connections between the cast walls. The fabric is then hardened with epoxy to finalize one of the two parts required for the formwork. The second part of the mould is a direct copy of the first. It is fabricated by applying a thin layer of rubber onto the first part, backed with a plaster cast support (Fig. 7d). Three complete formworks are reused twice for the concreting of 6 walls, later mechanically connected as a whole.

Overall, the method employed for the prototype is a much refined and more efficient version from the one executed for column 2. The high surface definition of the concrete walls (double-curvature) generates a high degree of surface suction on the formwork. A rigid mould would have subjected the concrete shells to large stresses during decentering and as a result they most likely would have cracked. However, the thin and ductile layer of rubber, introduced in the sandwich of the formwork, greatly contributed to the ease of the demoulding process.

G. Column 7 (Flaring and Sieving)

The exploration for this column starts with Robert Maillart beamless mushroom slabs structure. The ambition for the patented structural system was to suppress any beam supports between the slabs and the columns, reminiscent of timber and steel structures. To do so, Maillart proposed to flare the top of columns to decrease the bending moments in the slab, usually resisted by a set of beams. Not only, Maillart’s columns flared upwards to distribute the ceiling loads on larger areas, but some also flared downwards to reduce pressure on the soil foundation. The elimination of beams allowed the slab and columns to perform as a monolith connection [12].

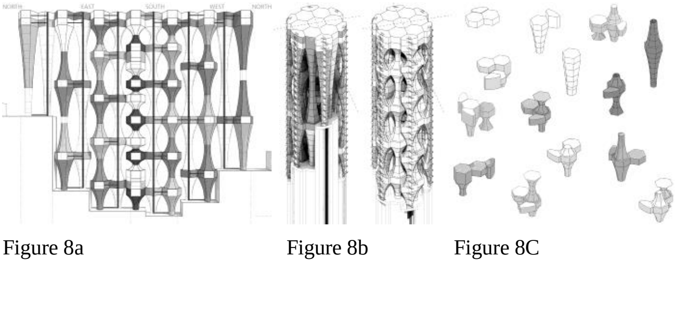

Figure 8a Figure 8b Figure 8C

Column 7 takes the doubly-flared primitive (top and bottom) and vertically repeats it to create a compound of 13 tall and slender elements of various periodicities and of changing density in section. The primary aim is to reorganize a multi-storey high-rise into partial aggregations of horizontal instants, unevenly distributed across the height of a column (Fig. 8a).
To free the horizontal datum internally, the central core has been relocated on the periphery, into six smaller cores. This process of *sieving* the horizontal discloses a high grade of porosity throughout the column's cross-section, given by the different periodicity of each slender column. The level of porosity distributed within the column, varies upon its orientation. Its density is calibrated based on analysis of yearly solar exposure. The greater the periodicity of an element is, the more shaded areas are created for indoor-outdoor living, as a consequence (Fig. 8b). Each vase-like element is habitable, yet a proposed living unit is not just confined within its own boundary. Rather, each unit type is formed from various aggregations of neighboring elements, when meeting at a specific datum. Having less periodic changes and therefore less density on the northern side, results in living units that are more vertically defined. In contrast, the ones facing south, by being subjected to a higher density ratio, are predominantly arranged horizontally (fig.8c). To address an irregular stepped ground, each of the thirteen footings of the concrete prototype can independently receive a range of height differences.

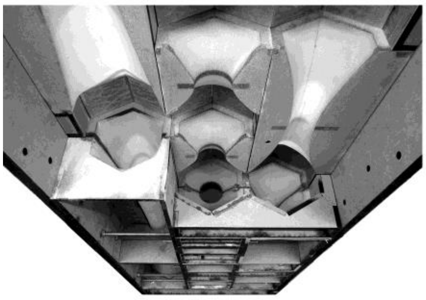

Figure 8d

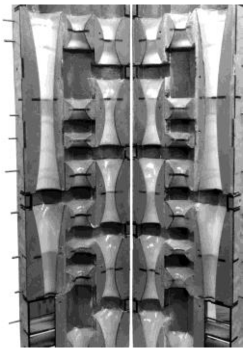

Figure 8e

The tested formwork method for the prototyping of this column is modular. The negative balusters are comprised of rigid parts for the slabs and soft ones for the vase-shaped elements (fig.8d). The vase-like modules are made with fabric stretched on wooden edge profiles. To fabricate the column, 9 two-part formworks are required; 1 of 3 balusters (Fig. 8e), 2 of 2 and 6 of 1. After casting, the 9 concrete parts are fastened together with rods piercing trough the top slabs of each concrete baluster.
In general, the fabric technique, incrementally developed throughout some of this prototyping exercise is not dissimilar to the one introduced by Philippe De L'Orme, now called stereotomy. This art of stone carving made efficient use of projective geometry by translating spatially complex solids into two-dimensional templates to guide the stone cutter in the carving of a block [13]. The method employed here also rationalizes complex solid geometries into frameworks of simple 2d profiles from which a softer material (geotextile) optimally interpolates the overall three-dimensional negative space for volume casting.

H. Column 8 (Splitting and Profiling)

Speculations on the line as vehicle to describe volumes of revolution are considered in the prototyping of column 8 and 9. A 5-axis custom-made automated hot wire is utilized as the main research tool.
By inputting specific protocols for synchronized motions (4 translations and 1 rotation), new topologies emerge defined by movement and time. These are further employed to section EPS foam blocks into part-moulds for thin shell concrete casting.

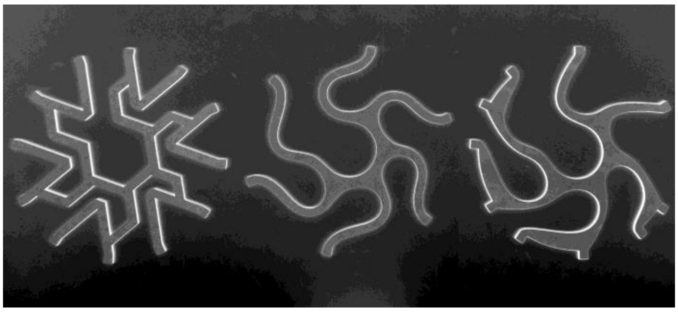

Figure 9a

Column 8 begins with the study of Pier Luigi Nervi's columns of varying sections found in many of his built work. Due to its plastic properties, reinforced concrete permitted Nervi to transform a column's profile from top to bottom in order to respond to different structural demands. Informed by 'objective static and construction consideration', the transition from changing sections is negotiated by straight lines connecting points on the contours of each section [14]. The lines are then directly translated into planks for the making of the formwork.

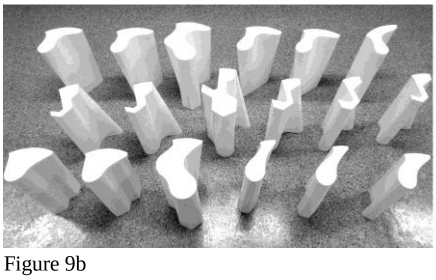

Figure 9b

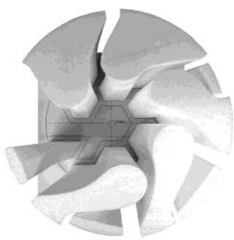

Figure 9c

Column 8 appropriates this geometrical procedure in vertical deformation. First, various 2d sections are identified within the shaft of the column (Fig. 9a). Then, the hot wire cutter takes care of deriving the resulting ruled geometry linking the different sections (Fig. 9b). Taxonomies of EPS-plugs subsequently make up for the negative volumes in between which the concrete is then poured (Fig. 9c).

I. Column 9 (Entangling and Cracking)

Column 9 expands on the procedure horizontally (Fig. 10a). In addition to movement, a time factor is introduced. New slab topologies arise from incremental protocols on a moving line in space.

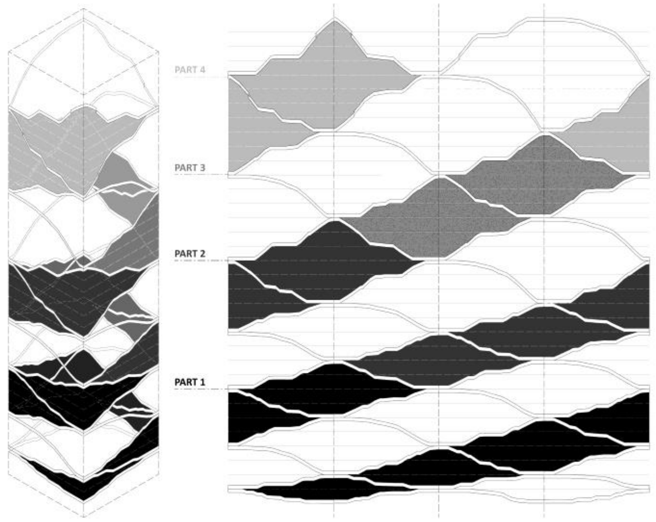

Figure 10a

Although the prototype is still in its infancy, early findings present unique slab topologies, whose forms would be difficult to preconceive through other means of digital fabrication. Being de-scribed by successions of straight lines, these intricate slabs retain an efficient and a direct link to timber formwork and full scale construction.

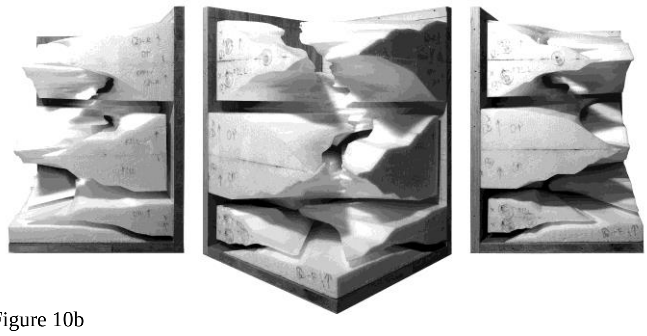

Figure 10b

The EPS mould-making method also resonates with the parallel made earlier on stereotomy, although this time by operating internally in the carving or slicing of a block (Fig. 10c).

III. CONCLUSION

One of the overarching research propositions is to reassert structural design and construction procedures as the main driver for new Housing organizations in a way that helps break from the uniformity of current post-slab systems (Fig. 11). By pursuing an empirical approach towards prototyping, alternative structural languages for point-block towers are discovered. New structural properties steer, at a variety of scales, the emergence of indoor-outdoor living, more amenable to social interaction within a built entity.

Figure 11. Concrete prototypes in city context

From a construction aspect, novel formwork techniques, making use of many material properties that are more flexible and economical than existing ones, are created throughout the prototyping process. The question of scalability of these formwork techniques still remains to be addressed. In following research projects, the author intends to further engage with the findings from these methods at full building scale.

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Of Belgian origin, he graduated with a degree in Architecture from the Cooper Union in New York and with an MSc in adaptive architecture and computation from the Bartlett in London. He has practised in New York, Lisbon and London and has taught design studios in Denmark, the UK and from 2005 to 2011 in Switzerland. In 2010, he also was a unit master at the Architectural Association.
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