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DESIGN CHALLENGES OF SOLVING CIRCULAR GEOMETRY IN RESIDENTIAL BUILDINGS

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Abstract

A dimensional geometrical shape such as a circular shape has been established all throughout the history of building design planning in order to find out the suitable arrangements for the living spaces: One of the most unusual designs planning in architecture is circular planning. Moreover, residential buildings that contain a circular plan are not built that frequently as well, but they still are a part of architecture since prehistoric times. Unfortunately, there are significant issues in such buildings, such as a structural challenge within the design module with orientation problems. In other words, there is a missing of the optimum use of space with acoustic problems including difficulties of furnishing. This paper therefore aims to provide the evidence that the geometry of a tiny minority of residential buildings are circular, and it questions why this is so. In addition, it intends to encourage the use of this type of buildings and to propose innovative design methods that can be applied in the circular residential buildings, trying to justify the architectural spaces to fit with the curvilinear walls and the recognition of the advantages produced within such buildings. To achieve this aim, this paper will begin by presenting literature review, based on desk research, carried out by re-reading the philosophical background of circular plans and its function. After that, the paper will theoretically highlight the historical use of circular-plan residential buildings, and will clarify the solution of design module, structural and services' cores, circulation between apartments, terraces, and external walls, within the curvy design. The paper will investigate two case studies such as "Tour Lumière" 2017 by Jacques Ferrier in France, Paris and "Edelweiss Residence" 2010 by Matteo Thun & Partners in Austria as a consequence to comprehend their project's concept and how they solved the circular form of their buildings.

Keywords

Circular Geometry, Circular Plan, Residential Building, Design, Function

1. INTRODUCTION

The Circular Geometry is a systematic generic symbol. It illustrates the notions of nature, whole, concentration, eternity, harmony, in temporality, the Sun, the Moon, and the whole Universe. A residential building is almost any house meant for private use, whether indefinitely or not. Single-family, trailer, "condo", half-detached, row house, and apartment construction are the different types of houses. Solar deities were worshipped in primitive and ancient times in various parts of the world and in various forms - all under the umbrella of a common symbol, the circle. As a mystical and symbolic sign, the circle can be seen in all traditions, sects, and belief systems. Philosophical way, the circle is a common symbol that has a number of various meanings. It reflects the Sun, the Moon, and the whole Cosmos, as well as totality, wholeness, concentration, eternity, harmony, and timelessness. Most of us are drawn to it because it is all about equality. After all, the Ancient Greeks designed whole civilizations based on geometric ideals and proportions of simple shapes like the triangle. This timeline of projects traces the recent history of circles in architecture, investigating how the form can give projects a sense of identification, introduce a dimension of suspense, or act as part of a broader structure of powerful geometries (Tissoire,2009). Buildings with a central plan in residential buildings are an unusual occurrence, but they have been built continuously since prehistoric times. Many ancient nomadic people used to dwell in houses/tents/shelters with circular plans (e.g., yurts, trellis, tepees, igloos, and many others) regardless of the conditions. Unfortunately, Nowadays, the circle plan is scarcely used in the construction of most buildings because, the circulation of people and goods inside the building is basic and the use of circular structures that renders it more difficult to furnish the framework and makes designs for perpendicular partitions more complex when it is easier to use a straight line and orthogonal designs while constructing any partition, wall, or cage. There is no major study on residential buildings in the literature, however there is no effort to establish a more reliable conceptual framework of buildings with circular plans that includes more than only circular plans. Because of the flexibility that circular plans offer for packing several spaces of different dimensions and sizes, circular plans are relatively uncommon in the building stock (Attia, 2010). Most of the pioneers argued elsewhere that the majority of buildings have a primarily rectangular geometry in plan so they prefer to use this concept instead of circular plans (Steadman, 2015). The aim of this paper is to show the evidence that the geometry of a small percentage of residential buildings are circular, and it questions why this is so. In addition, it intends to encourage the use of this type of buildings and to propose innovative design approaches for circular residential buildings, with the goal of justifying architectural spaces to match with curved walls. In addition, to explore examples with circular plans in residential buildings, to get a decent understanding of the theory behind their construction using several design criteria. This paper will shed the lights on the emergence of the circle, and then the square, were the most important landmarks in the history of architecture. Round structures were the first structures built by all cultures. Moreover, for good reason: circular designs use the least amount of material and have the maximum structural quality of any shape according to Steadman (Steadman, 2012). As settlement densities rose, the circular geometry gave way to the rectangular (orthogonal) geometry, foregoing the circular floor plans in favour of more streamlined configurations (close packing) and simpler management. The demonstration for greater energy efficiency, lower construction costs, full use of daylight, and greater versatility in the partition of the interior space by comparing a circular plan to an orthogonal one. In addition, combining a circular plan with orthogonally designed rooms within, is the most functional, according to many architects and users. A residential building's circular form offers a sense of protection while still defending against external factors such as temperature. (Steadman, 2015).

To achieve this aim, the paper will present a methodology, based on desk studies reviewing internet, books and papers. The research will be focused on qualitative research that provides an overview and definitions of circular plans. The study will look at the principles and techniques used on circular plan. Furthermore, the analysis technique employs a comparative and systematic approach that draws on a variety of case studies. It looks at new residential buildings built after 2010, as shown in "Figures 1 and 2", with a circular plan as well as its functions and concepts. It boosts on contemporary residential buildings designed and built by architects. In addition, the investigations were carried out using floor maps, sections, elevations, and photos. The designs were chosen from the papers and blogs, as well as written drawing materials and concept documentation.



Fig.1: Plot#4371-2015, Beirut, Architect Bernard Khoury. Source:” Khoury,2015”.

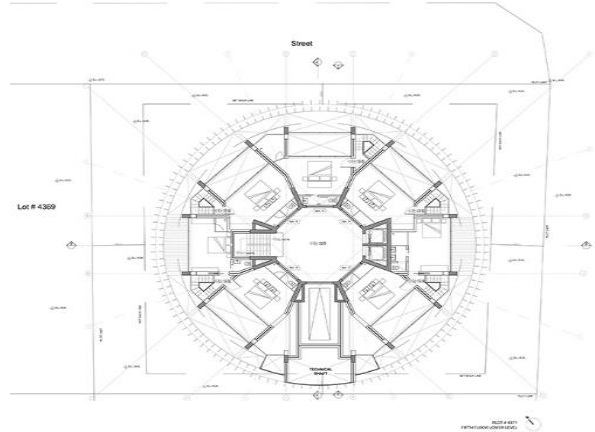


Fig.2: Plot#4371, Beirut, Architect Bernard Khoury, Residential Circular Plan. Source: “Khoury,2015”.

2. LITERATURE REVIEW

The relationship between circular geometry and architectural design is explained and illustrated by a literature review. Circular Geometry is the study of rounded shapes and their relationship to one another. A statement that the most effective solution is to combine a circular plan with orthogonally planned rooms inside (Steadman,2015).

2.1 Circular Geometry in Architecture: Historical Background

“A round house is so harmonious on site! This was well known by the ancient Romans and Renaissance architects.”

*This Quotation is mentioned in
‘The history of geometry’ (Tissoire,2009)*

The history of circular and radial-concentric building complex design can be traced all the way back to the beginning of human history as shown in “Figure 3”. A round architectural form offered a natural sense of unity. It was also a strategic means of defending against threats on both directions (Knapp,2011).

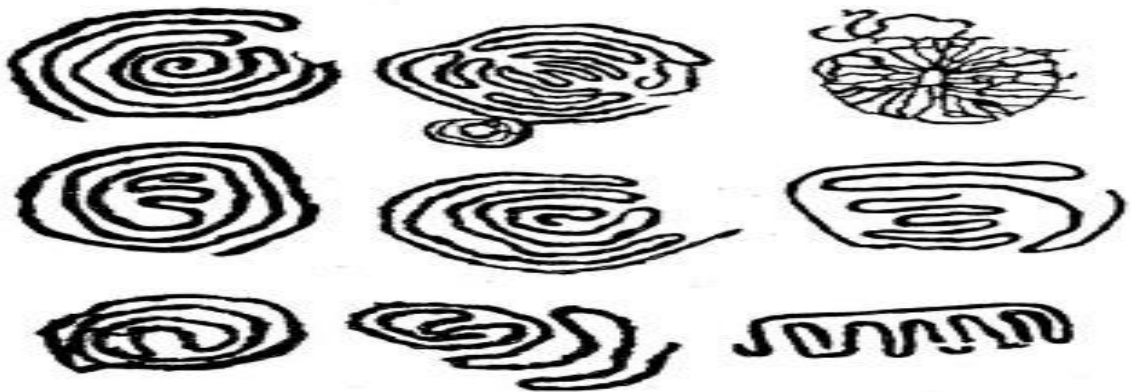


Fig.3: These rock carvings on the Spanish island of La Palma might indicate circular living quarters – although a more universal expression of doodling cannot be excluded.
Source: “Knapp, 2009”.

The Greeks regarded the Egyptians as the geometrical inventors. The scribe Ahmes, the writer of the papyrus Rhin, sets forth a law to determine a circle range that is $\alpha = 256/81$ or around 3.16. A circle of buildings, circular rampart, or tower with a circular plan were used at times when the preservation of people and their belongings was a frequent requirement. People in positions of influence throughout history have valued the circle as the most ideal of figures. The first conceptual design projects were either based on a circular focal building or used a circle or a ring to form the whole architectural layout. Solar mythologies were idolized in various parts of the world and in various forms in primitive and ancient times, all under the auspice of a popular symbol: the circle. The circle can also be identified in all traditions, faiths, and belief systems as a mystical and symbolic sign. The circle, for example, is used in Buddhist Mandalas to represent the sky, transcendence, and infinity. The Indian swastika (circular, not the one most people are familiar with) is a sun-worshipping symbol that symbolizes prosperity, fertility, and good fortune. A circle was combined with the sun cross, a symmetrical religious Celtic cross. After all, Geometric concepts and measurements of simple shapes such as the triangle were used by the Ancient Greeks to construct whole civilizations. This timeline traces the modern history of circles in architecture, looking at how the form can be used to give projects a sense of identity, introduce a layer of tension, or act as part of a wider structure of strong geometries. For the same reasons that homes in Europe were designed on a circular layout in the Middle Ages, residences in Chinese Civilization were built on a circular layout. Despite the fact that some of them were made of stone, the Chinese named them tulou, which means "earthen structure." Tulou is a family dwelling typical of Fujian's mountainous regions in the south and west. As shown in "Figures 4,5" A circular layout made it possible to establish a hierarchy or a community on equal terms. (Knapp,2011)

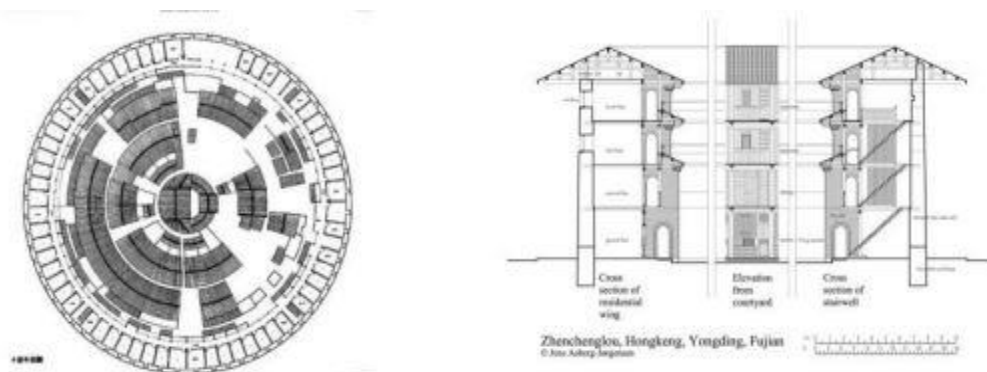


Fig.4,5: Internal elevation of Tulou Chengqilou, plan of the third story apartment and cross section through residences.

Source: "Jorgensen, 2012".

One of the ethnic groups that built these structures is the Hakka, as shown in "Figures 4 and 5". They used the properties of a circular plan to create a non-hierarchical society. All of the rooms were the same size, and one family owned vertically stacked properties from the ground floor to the roof. A cylindrical shape from the eighties of the 20th century became an aspect or a full volume (Botta,2012).

2.2 Circular Geometry in Residential Buildings: Definitions

Circular geometry are more than just a space and function; they often represent a sense or a symbol. It also has something to do with these elements themselves, their structure and mixture, their interaction with one another (syntax), their meaning (semiotics), and their effect on humans (pragmatics). Instances are used to describe and demonstrate the relationship between geometry and architectural design. The study of shapes and their relationships is known as geometry. Geometric forms, structures, and transitions represent approximately architectural design content.



Fig.6: Examples for circular geometry in buildings
Source: "Cylindrical Surfaces for Social Significant Architectural Projects, 20th".

Circular geometry has been used for decades because of several advantages it provides: A circle represents totality, order, and universal applicability. One of the basic principles is that all points on a circle's diameter are about the same distance from its own centre. The circle was selected as the symbolic feature because it is the shortest dimension form and the most compact geometric shape. It has only one dimension, the radius or diameter, and its centre acts as the point of reference. As shown in the research done by the architect Deaton, the architects reap the benefits of the circle's power by adjusting its appearance: The circle is the most effective two-dimensional form. As used symbolically, the architectural plan communicates by its shape. The circle, with its indication of the planets and other manifestations of nature, has had a spiritual, mystical significance since prehistoric times and was used in the plans of buildings, tombs, and religious institutions in many cultures. (Deaton,2012)

Residential Buildings with a circular plan are a rare occurrence according to Deaton, but they have been constructed progressively throughout antiquity time. Many primitive nomadic tribes used to live in houses/tents/shelters with central plans (regardless of climate), it was either promoting the building by wrapping the temporary structure or relocating the whole structure. A residential building's circular form provides a sense of protection, according to Tissoire, while also defending against large variety of problems such as temperature and earthquakes. In pre-industrial cultures, circularity in plan is also a trait of freestanding, widely spaced, single-room buildings. (The circular shape may be inspired by a building framework in which the roof is supported by a central pole or forms a self-supporting cone or dome.) The circular form has lost its importance in due time but again the architects have started exploring the idea of circular form in 20th and 21st century (Tissoire,2009).

2.3 Relevant Elements of Circular Geometry in Residential Building: Principals, Theories and Typologies.

Circular geometry has been used for decades due to the various concepts and beliefs they provided. A circle symbolizes completeness, order, and absoluteness (Steadman,2012(x2)). The fact that all points on a circle's circumference are almost the same distance from its own centre, here that form seems to have no beginning or ending, even though there is nothing behind or in front of it: it's one of the defining principals. There is no barrier, no edges, and no corners in this shape. Since it lacks edges and corners, this type seems to have a more continuous vision, which could be more attractive while seeing it from a distance, according to Steadman and many other architects. There are a range of approaches to the circle shape, including the difficulty of dividing so many spaces within it, as comparison to the square or rectangular form. As compared to rectangular or square shapes, designing a circular shape is more complex due to the demand of form work for various sizes of circles, in addition, with traditional rectangular or square-shaped furniture, there is more wasted space in the circular form according to Steadman (Steadman,2012(x2)). Despite its disadvantages, circular geometry can meet the current demand

for sustainability because they have a smaller surface area than rectangular forms with the same built-up area, have less heat gain, and can be used well in hot arid climates. Another benefit with a smaller surface area is that it would need less material and energy. In contrast with rectangular forms, the surface of a circular shape does not have a specific orientation; this form can maximize thermal comfort from either orientation as shown in “Figures 7 & 8”.

According to Steadman, a circular building style is considerably more resource-efficient than any other architectural design, including today's most environmentally friendly residences as shown in “Figures 7 and 8”.

It takes up less space: Construction seems to have a lower environmental impact; it takes less time to construct; as it's less expensive. It also cuts down on thermal energy gain and loss. Throughout the day, a Round plan receives continuous, optimal exposure to solar light and heat (Steadman, 2015).

The sun's rays are still perpendicular to the Roundhouse exterior wall during the day, making maximum use of the sun's light and resources. By comparing a circular plan to an orthogonal one, as shown in “Figures 9 and 10” a small comparison that shows how the simulation works between a circular and rectangular plan. The demonstration for energy efficiency, lower building costs, maximum use of daylight, and greater flexibility in the division of interior space is produced as shown in “Figures 9 and 10”.

Due to the geometric form of the constructed buildings, it was possible to discern the following specific styles of floor plans: 1. Circle (on a circular plan, with no deformations or only minor distortions that have no noticeable effect on a building's shape), 2. Deformed Circle (ellipse, flattened circle, "egg" etc.), 3. Circle with Cut-Out (a circular plan with one or more cut-outs, such as a floor plan shaped like an arc of a circle or a circular segment), 4. Circle with Add-on (a circular plan with a fragment designed orthogonally), 5. Multiple Circles (a plan made up of several circles/ellipses that are related or overlap each other), 6. Negative (an orthogonal plan with a patio in the shape of a circle, ellipse, or a portion of a circle, for example), 7. Arc (an elongated arc-shaped building, which may have more than 360° of arc and wrap around, forming a system of two or more storeys above each other in extreme cases).

Circle and Deformed Circle are the most common basic typologies. Circle with Cut-Out, Multiple Circles, and Negative, were the next three. No partitions solution necessitates the design of a building in the Multiple Circle typology, with each room serving a distinct purpose in its own circle, and Circle in Circle only works in very tall buildings as shown in “Table 1 and 2” (Steadman,2015(x2)).

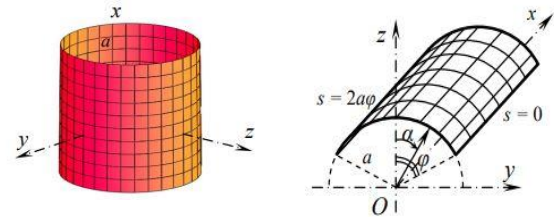


Fig.7, 8: Cylinder are a geometric solid with a cylindrical surface and two intersecting parallel planes. Source: “Steadman, 2012”.

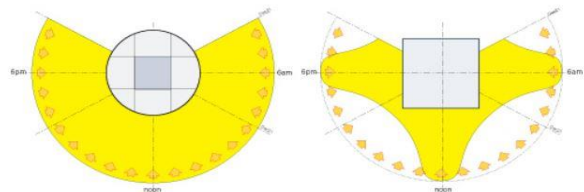


Fig.9, 10: Diagrams showing us the sun path between circular and rectangular plans. Source: “Steadman, 2012”.

Table 1: Typology of round buildings based on floor plan form.
Source: “Steadman,2015“.

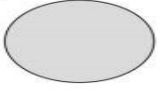
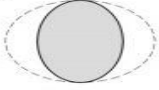
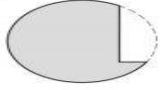
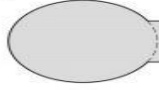
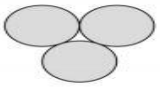


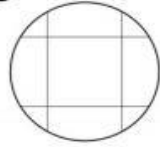
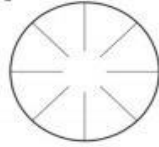
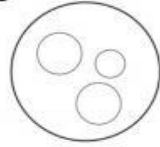
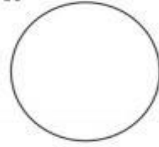
NAME	CIRCLE	DEFORMED CIRCLE	CIRCLE WITH CUT-OUT	CIRCLE WITH ADD-ON
SCHEME	1 	2 	3 	4 
NAME	MULTIPLE CIRCLES	NEGATIVE	ARC	
SCHEME	5 	6 	7 	

Table 2: Means of creating the interior space
Source: “Steadman,2015”.

NAME	ORTHOGONAL	RADIAL	CIRCLE IN CIRCLE	NO PARTITION
SCHEME	O 	R 	C 	NP 

2.4 Previous Readings

So many researchers and engineers have previously investigated the structural form and specific technology that allow us to choose the most suitable structural system for both design and load carrying problems. Innovative technologies that allow people to choose the right way to tackle various risks can be used to expand the use of circular plans in buildings and other facilities.

“Good people will say, “A round house isn’t ‘liveable.’ How are you supposed to arrange furniture when you have round walls?” These decent people forget that round houses have flat-surfaced walls and partitions; that rooms can be of a delicate fan shape, with windows in an arc toward the view; that a cupboard can easily and usefully fix an irregularity; and that, in serious cases, furniture with cylindrical backs can be installed.”

*This Quotation is mentioned in
‘The history of geometry’ (Tissoire,2009)*

This book offers a straightforward and definitive guide to the theory of buildings, a subject of critical significance to mathematicians interested in group theory's geometric aspects. Its rigorous presentation makes it appropriate for both graduate students and experts. Richard Weiss starts with an overview of Coxeter groups, then moves on to fundamental properties of abstract systems before focusing on the circular residential buildings. The language of graph theory is used to explain the structures in.

*“If people do not have angles, then we should not live-in boxes,”
This Quotation is mentioned by (Deaton,2012)*



Fig.11: Picture of the book 'the structure of spherical building ' .
Source:" Wills, 2012".

2.5 Parameters of Analysis

This table analyses some of the dedicated criteria of circular plan construction in contemporary architecture, as well as the other keywords, based on the preceding research:

Table 3: Parameters Investigation- circular geometry in residential buildings

1-Concept and meaning	2-Expressive forms And organizations	3-Circular form concept	4-Environmental studies	5- Panoramic View 360° views
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While exploring circular geometry in residential buildings, these parameters must be considered. The following case studies justify them. For example, through using a circular plan in Broadway Malyan, 360° panoramic views are achieved.

3. METHODOLOGY

This research is based on three main methods. The first was used to accumulate data about the three case studies that were chosen by consulting a number of sources. The second was used to interpret these data, providing graphs, sketches, and diagrams to help illustrate it much further. The study will be qualitative in nature and will give an overview and definitions of circular designs. The research will focus on the circular plan's concepts and methodologies. Furthermore, the research method takes a comparative and methodical approach, drawing on a range of case studies. It promotes architect-designed and built modern residential structures. In order to further our objective of discovering new technologies and understanding the difficulties that architects, owners, and students face while designing circular structures, a survey titled "Design Challenges for Solving Circular Geometry in Residential Buildings" will be performed to answer the questions. In addition, floor maps, sections, elevations, and photographs were used in the studies. Papers and blogs, as well as written drawing materials and idea documents, were used to choose the designs. Comparative analysis of the two case studies was the third process. In this sense, the researchers used the parameters specified in table 3 to evaluate the case studies that were chosen based on the following criteria:

- Studying different examples in different location and regions.
- Investigate diverse background and concepts between circular and non-circular buildings.
- Different interior design and type to be interpreted.
- Analyse completed projects to see how they used to work on different types of geometry in residential buildings.

Furthermore, Discussing the pros and cons of these projects is essential to know how they implemented this circular form, an analysis of the parameters will take place between two examples of circular buildings and one example of a non-circular building.

3.1 Case Study One: A circular Building Analysis: Edelweiss Residence / Matteo Thun & Partners

- Location: Spittal An der Drau District, Austria.
- Architect: Matteo Thun & Partners
- Date of Opening: 2010
- Area: 4000 m²
- Environmental approach: Low-energy building



Fig.12: residential building exterior shot of “Edelweiss residence”
Source: “Christian Wöckinger, Jens Weber, 2010”.

In Katschberg, Austria, ERLACHER will complete luxurious apartments. In the Alpine region, the edelweiss Residences are an architectural new structure tab;l. Nature in its purest form, clear air, and a plethora of comfort and relaxation differentiate this resort near the Katschberg. Balancing the basic conditions of reverence for Nature and Tradition, as well as the needs of the tourism industry, is a difficult task. Building in the Alps necessitates a constant quest for stability, as well as a constant search for new ways to build ecologically sound structures. The two circulars residential buildings, each measuring 20 meters in diameter and differing in height, balance the assigned floor and accommodate 64 apartments ranging in size from 45 to 180 square meters. Both apartments have a panoramic view of the natural and unaltered scenery due to similar configurations with varying scales. A simple configuration is available in two different types of décors: a new, urban flavour or a more classic, traditional alpine option. Their guests, according to Thun, will enjoy the facilities of this residential building while maintaining the anonymity, space, and freedom of their own four walls. These luxurious residences, with their architecture, are situated at an altitude of 1.600 meters in the magnificent mountainous area of Katschberg, Austria, and are directly adjacent to ideally prepared ski slopes. Wood, the primary construction material, is put to the test once again by adopting the slogan "kilometre 0." A round bodied diamond spheroid frame made of local larch wood wraps, the two cylindrical bodies, symbolizing the direct connection to the world and fusing the inside and the outside (Thun,2010).

3.1.1 Concept and meaning

According to Thun, the circle is a common symbol with a wide range of interpretations. Totality, wholeness, concentration, eternity, harmony, timelessness, the Sun, the Moon, and the whole Universe are all represented by it.as shown in “Figure 13”. Thun believes that most of them are attracted to the Circle because it is all about inclusion. Our circle (of friends), our life circle, or, much better, our circle of confidence (Thun,2010).

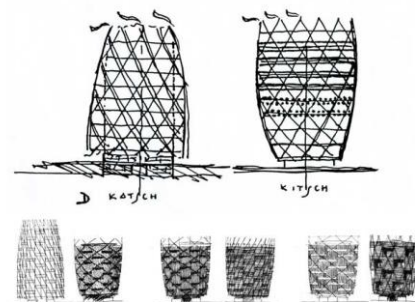


Fig.13: “Edelweiss residence” conceptual sketches
Source: “Thun, 2010”.

The two cylindrical bodies are wrapped in a round limbed diamond spheroid structure made of local larch wood, symbolizing the close relationship to the universe and fusing the inside and the outside. The project takes advantage of a special aspect of circular plans: the opportunity to build continuous, curving façades with panoramic views of the surrounding countryside. This efficiency is enhanced by the location of outward facing windows in each apartment, which takes advantage of the high solar gain inherent in this configuration. It wasn't just pro-social forces that influenced the use of core solutions over the last few decades (Thun,2010). New aesthetic experiences, of which millions of people are now a part and which require commercial flights, are becoming increasingly common. In such a scenario, an urban planning layout with a given, identifiable shape serves as a source of visual experiences as well as knowledge about the location of this house (Steadman,2012). The circular architecture currently lends itself to the project's primary mission of gathering people for both touristic and residential uses — a canvas-covered, ring-shaped structure provides refuge for visiting families. The private residential spaces in this design for a modular cylindrical building are stacked inside a circular superstructure rather than being curvilinear. This structure generates public transitional areas between the units that may be used in a variety of ways and offer panoramic perspectives of the surrounding urban landscape as well as snowfalls in the winter. Thun expressly designed two vertical towers to avoid the normal urban sprawl of a winter activities area. A solution was discovered that is in keeping with the ambient atmosphere by maintaining the surrounding green soil and reducing the floor space to the bare minimum (Thun,2010). According to this concept, no supplementary roads were required to connect the two apartment towers to the nearby village, which provided all essential services to the inhabitants, according to this architectural concept.

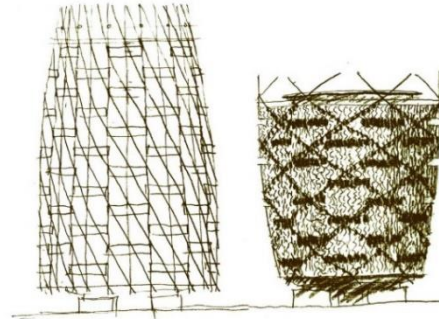


Fig.14: “Edelweiss residence” conceptual sketches
Source:” Thun,2010 “.

3.1.2 Environmental studies In Circular Geometry

Many indigenous peoples have depended on circular dwellings for centuries – think of the igloo, yurt, tipi, or Aboriginal humpy (Steadman,2012). According to Thun and many other architects, Circular houses used less materials than square houses, making them an appealing choice when supplies were limited and extra labour meant wasting valuable energy (Steadman,2012).

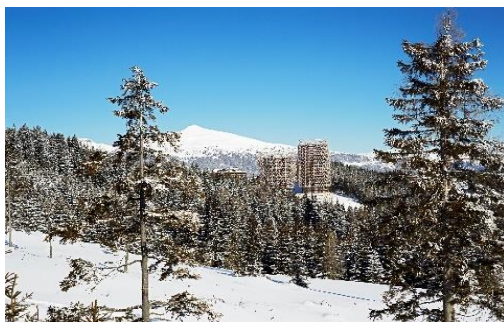


Fig.15: “Edelweiss residence”.
Source: “Christian Wöckinger, Jens Weber, 2010”.

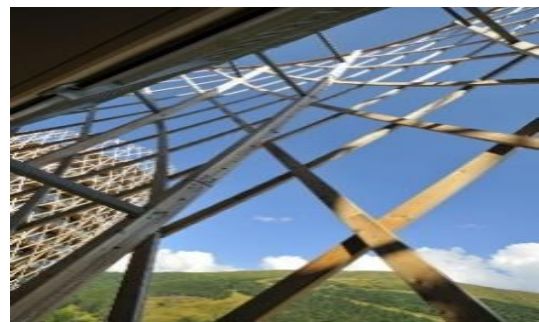


Fig.16: “Edelweiss residence”.
Source:” Christian Wöckinger, Jens Weber.2010”.

This conventional circular building will be able to withstand harsh conditions. Because of their angled roofs, they are less susceptible to extreme gusts lifting the roof and tilting the house up. These towers are less vulnerable to hurricanes and tornadoes because wind will circulate through the oval frame instead of being hung up around the angles (Thun,2010). Curves are used for a variety of purposes in contemporary architecture, The Edelweiss Residence refers to the corner location it sits on, overlooking the mountains. The building and its curves perform well in close proximity to nature, reflecting a sense of fluidity and openness. The building's back is also bent, and it opens up to the north. In other word, the building's direction in relation to the sun's radiation may influence energy use by rising or decreasing solar benefit. In the current analysis, there were no major differences in the research and parameters findings. After considering various orientations, the building's energy usage was monitored (Thun,2010). The building was originally located at a 360° open angle. Since shading is one of the most effective ways to reduce cooling loads, the impact of shading implementation on energy consumption has been studied in order to determine the best shading depth by using the wooden louvers in these two towers. As compared to a rectangular home, this Circular building has a smaller surface area due to floor space, which means that since there is less area exposed to the cold weather outside, it would require less energy to heat and cool the interior. These round buildings are also more aerodynamic, allowing for less draughts to enter. According to Attia, a circular house is more energy efficient than a rectangular house because there is less dead area for cool air to accumulate and because the wind diffuses through the structure rather than catching a wide concrete wall (Attia,2010). The wooden spiral "diagrid" construction offers an aerodynamic shape with the least amount of wind resistance. The building's form also lowers the strain on the load-bearing system and the danger of heavy winds in the local area as shown in "Figures 15 and 16".

3.1.3 Expressive forms and organizations

According to Thun, the project's architecture began with two simple cylinders since the circular plan uses the least amount of floor space, as shown in "Figures 17 and 18", but also producing the most density with the least amount of surface area, which decreases the amount of sun exposure surface area (Thun,2010). To maintain a strong system, a structural program's primary role is to provide the necessary equilibrium, stability, weight, stiffness, ductility, occupant comfort, and constructability. Of necessity, the structure must be meticulously built to match the architect's excitement. Both points in the interior of a circular building without a courtyard are accessible from all other points if it has a fully open plan. This is a characteristic of convex forms in this case study. As we will see, circular plans have appealed to certain planners who needed to see more distant spaces or locations from a central vantage point. The building ratio and absolute diameter values will have a big impact on how various building forms in this kind of orthogonal open plan function, and they can also determine if an open plan is even feasible.

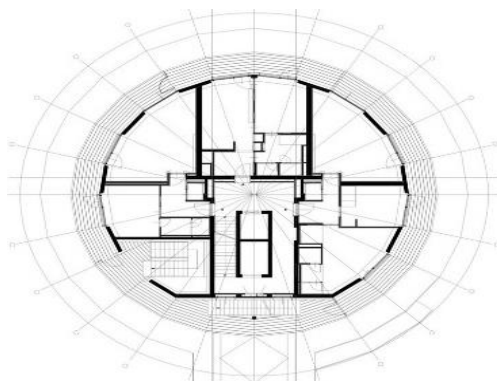


Fig.17: "Edelweiss residence "plans.
Source: "Christian Wöckinger, Jens
Weber,2010".

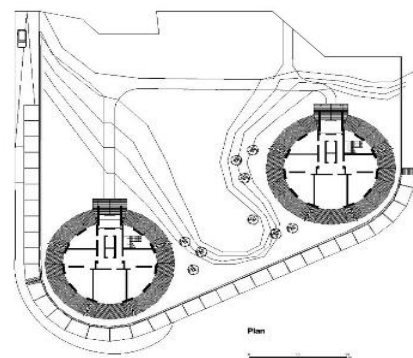


Fig.18: "Edelweiss residence "plans.
Source: "Christian Wöckinger, Jens
Weber,2010".

Certain buildings, on the other hand, are exempt from the limits of two-dimensional packing because they are made up of either one large open space, or one large central space with several smaller spaces added along the perimeter. This are the groups in which the “Edelweiss Residence” mentioned here fit (Thun,2010). The two circular facades, in particular, include and support suspended groups of floors that are “squaring” the façade's full radius to make the internal space orthogonal and habitable.

3.1.4 Panoramic view (360°)

The translucent façades of the residential tower, according to the architect, have stunning views of the entire snowfall, as well as a 360° view of the surrounding mountains and trees. Due to its height and characteristic cylindrical shape, the " Edelweiss Residence " is a rural landmark. Due to its position, the building's façade is brought to life by wooden structural skin, which provides a sense of shelter and protection. During the winter, the building's exterior was built to simulate the snow on the mountains in order to create a comfortable vision to the users. It has an impact on human comfort, fitness, and mood, but the effects vary depending on where they are. It is an important part of the construction of a building in architecture, and it provides meaning. It increases the visual comfort of the rooms while also increasing the energy efficiency of the house (Thun,2010). It affects the requirements of rooms and interior spaces. They enable control of the type of lighting required based on use, in addition to visual comfort. Form, scale, texture, colour, harmony, unity, rhythm, focus, contrast, symmetry, proportion, space, alignment, style, design, history, and meaning all have an effect to this cylindrical façade, according to the architect's concept. Gives the room a sense of wholeness with a strong Visual Connection to Nature and snowfalls; it catches one's eye and can be relaxing or soothing. It has the ability to relay information about time, temperature, and other living objects. It showed reduced stress, enhanced emotional performance, and improved concentration and recovery. Stress restoration through sensory interactions with nature was achieved in this project according to the architect.



Fig.19: “Edelweiss residence
“exterior shot.

Source: “Christian Wöckinger, Jens

Table 4: highlights the parameters in “Edelweiss Residence” where each parameter is texted within the table as follows:

Table.4: Highlighted parameters Investigation- circular geometry in residential buildings

Parameters	Descriptions
Concept and meaning	The symbol of the close relationship to the universe and fusing the inside and the outside.
Expressive forms And organizations	Orthogonal plan with an open space.
Circular form concept	Totality, wholeness, concentration, eternity, harmony.
Panoramic view (360°)	The transparent façades have stunning views of the entire snowfall, as well as a 360° view of the surrounding mountains and trees.
Environmental studies	Highly least to hurricanes and tornadoes

3.2 Case Study Two: Le Galion

- Location: Paris, France
- Architect: Jacques Ferrier Architect
- Date of Opening: 2017
- Area: 5300 m²
- Environmental approach: Low-energy building

The unique landscape of Le “Galion”, a combined architectural project, blends with the channels of the Cher River (Ferrier,2017). The project is centred on a garden that stretches like a belvedere across the Cher River and includes a residential building (La Tour Lumière), and a company restaurant. According to the architect, the transparent façades of the residential tower have panoramic views of the river and it’s considered as an urban landmark due to its height and distinctive cylindrical shape. The building's façade is brought to life by subtle white and metallic reflections, which give a sense of lightness and transparency that differs depending on the natural light, in other words, it has a 360° view of the river, area, and surrounding landscape. The Tour Lumière offers both rental and purchase of affordable housing, as well as regular housing. Each floor has its own balcony and the mixed-use plot's standout is this one-of-a-kind residential home. The landscape merges with this residential building in a seamless manner. The panels of the brise-soleil and the terraced plan emphasize this horizontal style. Indeed, the design of a building like the Tour Lumière necessitates continuous effort upstream in order to fully comprehend all of the project's problems and restrictions. The novelty of this building approach is expressed in a variety of logistical limitations that necessitate extra caution in site management and organisation. The Lumière Tower faced a huge challenge for the construction workers, as it was constructed on a highly heavily populated site with a limited footprint, with the Cher and its current infrastructure on one side and the structures that remained functional during the construction time on the other. As a result, detailed procedures for ensuring the availability of supplies on site had to be placed in motion (Ferrier,2017).



Fig.20: exterior photograph of “Tour Lumiere”

Source: “Luc Boegly, Mathieu Ducros,2017”.

3.2.1 Concept and meaning

As mentioned above, the residential tower provides panoramic views of the river according to its translucent façades with a 360° view of the river, surrounding city, and scenery. Because of its height and distinctive cylindrical shape, the “Tour Lumière” serves as an urban landmark, according to Ferrier. The aim is to predict an optimum site organization by using techniques such as prefabrication of curved walls or casting cores with two layers of advance casting. The key reasons for using the circular plan approach in this project, for structures, according to the architect, were urban aspects such as optimizing the view, incorporating the architectural form into the landscape, and ecological aspects such as energy savings. The effective use of daylight

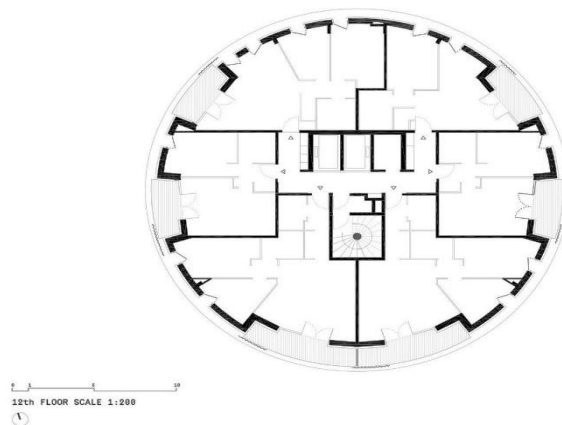


Fig.21: residential plan of “Tour Lumiere”
Source:” Ferrier Project, 2017”.

and the contrast with the surroundings were two other common factors for constructing this building with this circular shape. The explanation for this is that it is possible to resist creating rooms with irregular shapes that are impossible to furnish this way. The buildings under investigation are all in the open landscape residential sector. Buildings with irregular forms, such as circles, have a greater chance of integrating into areas where development density is minimal or zero at all (Steadman,2012). There is no clash between the former orthogonal buildings and the current circular building in this case (Ferrier,2017).

3.2.2 Environmental studies In Circular Geometry

Based on Ferrier’s observation, there is less embodied energy. When it comes to this circular layout, the general concept is that a basic form can last way longer than a complicated one. The circle has the shortest boundary in terms of area of any form. This means that a circular building has less wall length and therefore uses less material for any given floor area (Ferrier,2017). A square is the next most effective space, followed by a rectangle (Steadman,2012). In other words, Efficiencies in energy, since the circular building have a smaller surface area than square houses, there is less exposed surface space to the elements (Steadman,2012).



Fig.22: residential building exterior shot of “Tour Lumiere”
Source: “Boegly,Ducros, 2017”.

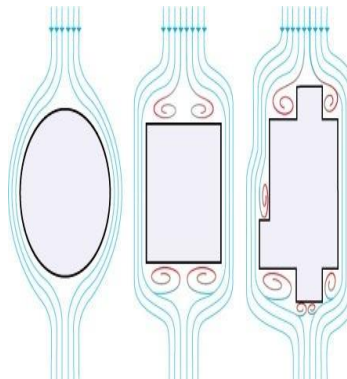


Fig.23: environmental studies
Source: “Massau, 2017”



Fig.24: residential building exterior shot of “Tour Lumiere”
Source:” Boegly, Ducros, 2017”.

As a result, they use less resources to keep their interiors at a reasonable temperature, allowing for less draughts and thus being more energy efficient. They used to study the resistance to earthquakes and the wind, there are plenty of interconnected points in a round buildings, which offer it a rare mix of stability and resilience – properties that make it much stronger in earthquakes (Ferrier,2017). According to Ferrier, “Tour Lumiere” is also more resistant to hurricane-force winds due to their aerodynamic properties (and tsunamis for that matter). Highrise apartments, on the other hand, are battered by the same waves, which will ultimately kill them if the winds are high sufficiently. In areas vulnerable to storms and gale-force winds, round towers are a suitable option as mentioned in this case study. Wind preparation, which happens when a heavy wind raises the roof framework up – and often off the building – is less of a problem for a rounded roof. The circular residential building is made up of thousands of interconnected points that offer it a rare combination of stability and strength, making it considerably more earthquake resistant than rectangular houses. In addition, winds and Tsunami waves instinctively pass around a circular building instead of being stuck on corners as shown in “Figure 23”. (The data in this part are taken from the architect’s perception)


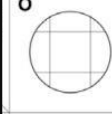
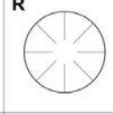
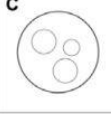





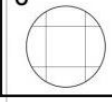

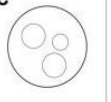
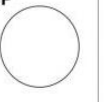
3.2.3 Expressive forms and organizations

With no beginning and no finish, the circle represents beauty and peace (Ferrier,2017). The visual perception of a globe, including the Sun and Moon in the sky and various representations of flora around us, is one of the first intentional ideas for Ferrier in this case study.

According to Steadman and Ferrier, there were four distinct ways of organizing the living space. The first one is the orthogonal form, where the internal walls of the building are designed on an orthogonal grid, the rooms have at least 3 straight, perpendicular or parallel walls and only external walls are curved as shown in “Table 5”. The second one is the conservative form where the walls are designed perpendicularly to arched walls, like cutting a volume into pieces, rooms have two straight walls which, however, are not perpendicular to each other; the larger is the size of the building, the third one is the circle

Inside a circle where the spaces are separated by smaller circles or parts of arches. The last one is the where we don’t have partitions in particular circles, each circle is a separate room. In certain houses, several ways of shaping the space are used. When considering the above-mentioned methods of forming interior space, orthogonal form solutions are used in this case study. In this example the orthogonal solution is used since it provides a large number of straight, perpendicular, and parallel walls, making furnishing easier, as we can see in the plan as shown in “Table 5” (Steadman,2012).

Table 5. creating the interior space
Source:” Steadman, 2012”.

MEANS OF CREATING THE INTERIOR SPACE TYPOLOGY	O	R	C	NP
	1 + 6 			
2 + 6 				
4 + 6 				
				
NAME	ORTHOGONAL	RADIAL	CIRCLE IN CIRCLE	NO PARTITION
SCHEME				

3.2.4 Panoramic view (360°)

Residential Building planning issues associated with the industrial revolution arose in subsequent decades. This came down to ensuring that their citizens had respectable living arrangements. During that period, a number of ideas based on concentric, circular layouts were created (Ferrier,2017). The aim of this concept was to provide city dwellers access to open green spaces, minimize smoke emissions, and increase living and working conditions. Based on the author's perspective, the transparent façades of the residential tower have spectacular views of the river, as well as a 360° view of the landscape, surrounding area, and foliage. The "Tour Lumière" is a city landmark due to its height and distinctive cylindrical shape. The building's façade is brought to life by subtle white and metallic reflections, which provide a sense of lightness and clarity that varies depending on the natural light. The facade of this building was designed to reflect the Cher River's eternity/infinity symbol and many other facades shapes.



Fig.25: residential building exterior shot of “Tour Lumière”
Source: “Luc Boegly, Mathieu Ducros, 2017”.

The perforations in the building's façade function as a solar shield, allowing sun, air, and views to pass through to the internal occupants. Since the house had no good or poor sides, balconies could be found on both sides, and they all had decent views. Curving the balconies softened the building's effect while still providing tenants with better views (Ferrier,2017).

Table 5: highlights the parameters in “Tour Lumière / Jacques Ferrier Architecture” where each parameter is texted within the table as follows:

Table 5: Parameters Investigation- circular geometry in residential buildings

Parameters	Descriptions
Concept and meaning	The “Tour Lumière” serves as an urban landmark.
Expressive forms And organizations	Orthogonal plan with a simple form
Circular form concept	The visual perception of a globe
Panoramic view (360°):	The transparent façades of the residential tower have spectacular views of the river
Environmental studies	Less embodied Efficiencies in energy, direct sunlight

3.3 Case Study Three:A non-circular residential building: Hatsuse Mita Apartments / ihrmk

- Location: Minato City, Japan
- Architect: ihrmk
- Date of Opening: 2019
- Area: 852 m²

The owner's penthouse is usually located above the rental apartments in an owner-occupied rental apartment complex (ihrmk, 2017). Hatsuse Mita is likewise an owner-occupied property with a few rental apartments, but the layout is very different. The owner's family was forced to relocate owing to a redevelopment project in the neighborhood, and they need a new house that could adapt to changes in their family structure and society. Instead of a single house for the entire family, they presented a concept in which each unit has its own floorplan and may be rented out or regarded as an "individual room" within the family's home. The family can shift from one unit to another in this non-hierarchical layout, depending on the sort of space they require at the time of change in the future.



Fig.26: residential building exterior shot of “Hatsuse Mita Apartments”
Source: “Inatsugu Taisuke, 2020”.

3.3.1 Concept and meaning

Private and community areas are structured like edge parts of a broken line, not blocked off or open to each other. Hatsuse Mita is a "large house" in the sense that its inhabitants may keep the same amount of solitude and intimacy as they had in their previous residence. Blending the interior and the outdoors together. The property is surrounded by large-scale residential structures and a neighborhood of low-rise wooden homes along a major road. They chose an intermediate structural scale based on the significant contrast in texture and proportions between these two areas: a frame made with 310mm square columns spaced 1350mm apart. An open "Meguri-doma" in the center of this basic construction links all floors. "Open terraces," "Inner terraces," and "Living areas" are arranged in various ways around the structure to blend inside and out. This tiered net-like construction was supposed to provide an airy sense to it. Many structures with only one room – or one large room plus a few much smaller connected areas, such as porches or lobbies – have circular, elliptical, hexagonal, or octagonal plan perimeters (Steadman,2012).

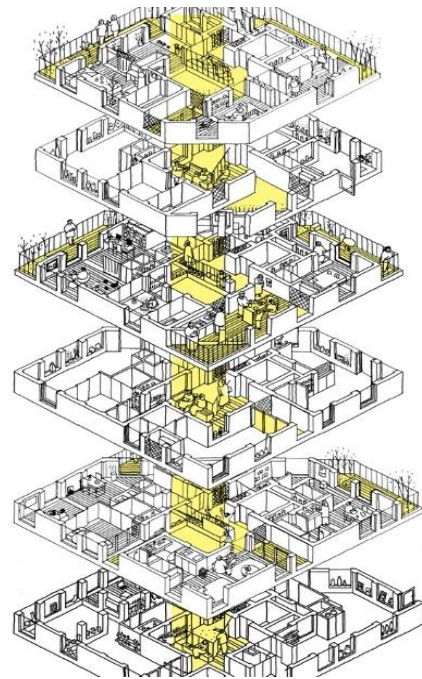


Fig.27: residential building concept and plans of "Hatsuse Mita Apartments"
Source: "ihrmk, 2019".

3.3.2 Environmental studies in rectangular Geometry

The "Meguri-doma" (covered stairway / common hallway) is meant to keep the sun out of the interior terraces and living areas while allowing the wind to flow through. As a result, the staircase transforms into a flowing area with both interior and outdoor vibes. In addition, square and rectangular forms are much easier to harmonize, and there is generally less waste (ihrmk,2019). Changed forms not only use more materials and assets, but they also cost more to build and maintain (Steadman,2012).

In terms of structure, psychology, and space, 90-degree angles are extremely powerful. Vertical stacks and vents are more aligned. Roof planes are becoming more straightforward to construct. The temperature and air circulation are better regulated. Electrical and water connections are also simpler to include (Steadman,2012).

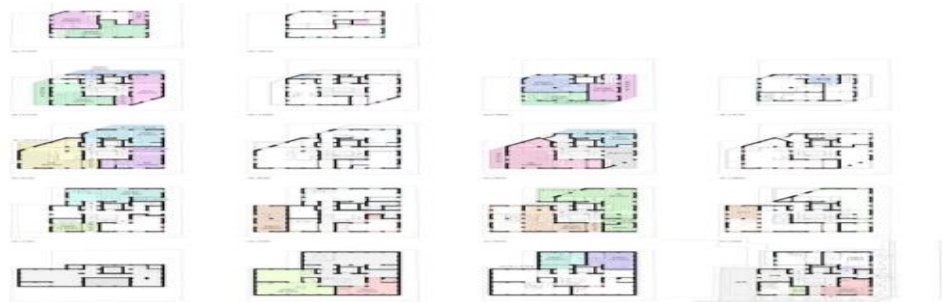


Fig.28: residential building concept and plans of "Hatsuse Mita Apartments"
Source: "ihrmk, 2019".

3.3.3 Expressive forms and organizations

Furthermore, one very essential feature of flexibility in the potential packings of forms to fill the plane is the rectangular form (Ihrmk, 2019). According to the architect, he believes that he had arrived to the core of the problem, the primary reason for rectangular packing's superior flexibility over other shapes that fill the plane. That flexibility stems in part from the wide range of possibilities for rectangle configurations, regardless of size; but it also stems from the ability to assign different dimensions to those configurations while maintaining their rectangularity (Steadman, 2012). Whatever, for Steadman, rectangular packing may be dimensioned in any manner and the component shapes will all be rectangles. Looking at this flexibility from another aspect, each rectangle within a packing may be divided into two rectangles, and each of these rectangles can be divided into two more rectangles, and so on. The designer might opt to split one suggested rectangular room into two in the context of plan arrangement. He can also, according to Steadman, squish together groups of rectangular spaces or pull them apart and slide others in between. A new partition wall can split any rectangle room into two rectangular pieces in a structure that has already been erected. (Steadman, 2012)



Fig.29: residential building concept and plans of “Hatsuse Mita Apartments”
Source: “Inatsugu Taisuke, 2020”.

3.3.4 Panoramic view (360°)

In this case study, there's no “360° views”, “90° corners” are used

Table 6 highlights the parameters in “Hatsuse Mita Apartments” where each parameter is texted within the table as follows:




Table.6: Parameters Investigation- circular geometry in residential buildings

Parameters	Descriptions
Concept and meaning	Blending the interior and the outdoors together
Expressive forms And organizations	Essential feature of flexibility in the potential packings of forms to fill the plane is the rectangular form
Rectangular form concept	Power
Panoramic view (360°):	There's no “360° views”, “90° corners” are used
Environmental studies	90-degree angles are extremely powerful. Vertical stacks and vents are more aligned.

3.4 Comparison Table

After analyzing the two consecutive projects and identifying of significant architectural representations in “Circular geometry in residential buildings”. This comparison is shown in table 87

Table 7: Comparison analysis between the two case studies

Case Study		Edelweiss Residence	Tour Lumière	Hatsuse Mita Apartments	
Parameters of Analysis					
Location		Spittal An der Drau District, Austria.	France, Paris	Minato City, Japan	
Date of Opening		2010	2017	2019	
Architect		Matteo Thun & Partners	Jacques Ferrier Architect	ihmk	
Parameters	Concepts	Concept and meaning	the “Tour Lumière” serves as an urban landmark.	The symbol of the close relationship to the universe and fusing the inside and the outside.	Blending the interior and the outdoors together
	Methodologies	Environmental studies	less embodied Efficiencies in energy, direct sunlight without the use of skins	Highly vulnerable to hurricanes and tornadoes including the use of wooden skin	90-degree angles are extremely powerful. Vertical stacks and vents are more aligned.
		Expressive forms And organizations	orthogonal with simple closed space.	Orthogonal plan With an open space.	Essential feature of flexibility in the potential packings of forms to fill the plane is the rectangular form
		Panoramic view (360°)	Visual aspects to the outdoor area through specific rooms	Direct connection from all the rooms to the outside area	There’s no “360° views”, “90° corners” are used
		Flexibility	Flexible	Flexible	Flexible
Concept and methodology		landmark concept, Aesthetic Value, energy savings, Fixed plan, connection to the landscape.	Inside and outside connection concept, approach to the environment, User comfort, Visibility from all the rooms.	Powerful building: Blending inside and outside.	

The paper can conclude the following from this table, it may reach to certain findings as follows in the data collection.

3.4 Data Collection

In order to build on the topic's knowledge and achieve the paper's main aim, the authors prepared a detailed questionnaire. The online survey, which included topic-related questions that defined the issue and emphasized the paper's aim, was sent out to a group of 40 people, including academics, architects, and users. The poll asked on the following topics:

- Expressive form and composition
- The concept of the circular form
- Panoramic 360-degree view
- Environmental studies in circular residential buildings

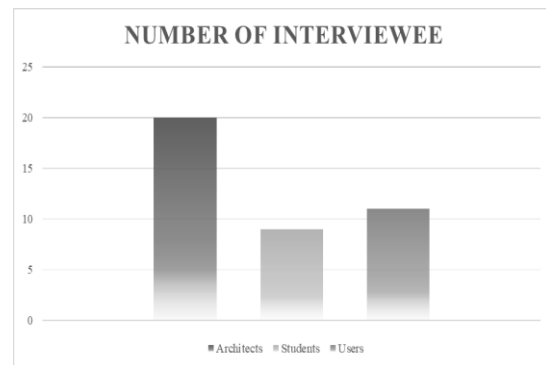


Fig.30: Chart showing the targeted users

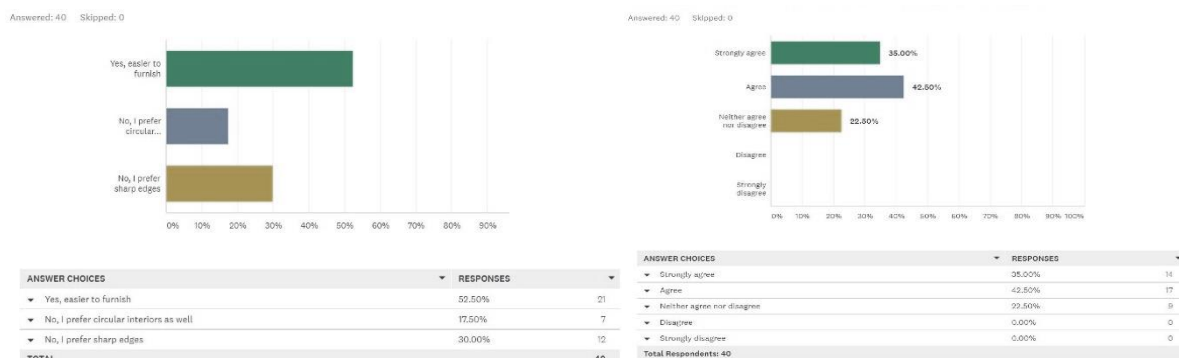
4. FINDINGS

A survey themed "Design Challenges for solving circular geometry in residential building" was undertaken to respond our questions in order to further our goal of discovering new technologies and understanding the issues that architects, owners, and students confront when creating circular buildings.

The survey's declared questions are as follows:

1. Expressive Form and composition: Would circular buildings with orthogonal interiors be something you approve of?
2. Do you think, a circular plan in residential building is an Earthquake and wind resistance because it has dozens of interconnected points which give the building a unique combination of flexibility and strength?
3. Circular Form Concept: How would you consider residential buildings to be?
4. Environmental Studies: According to many Architects and studies, round buildings reduce the number of materials needed by 30%. Would you encourage the increase of circular buildings in order to help environment concerns?
5. 360-degree vision: Do you believe that the sensation of sight has a significant part in the design concept of the circular residential building?

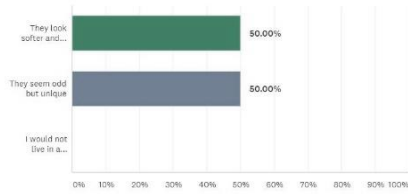
The responses were presented in the below graphs in order to discuss them and get to some conclusions.



Question-1- Expressive Form and composition: Would circular buildings with orthogonal interiors be something you approve

Question-2-Do you think, a circular plan in residential building is an Earthquake and wind resistance because it has dozens of interconnected points which give the building a unique combination of flexibility and

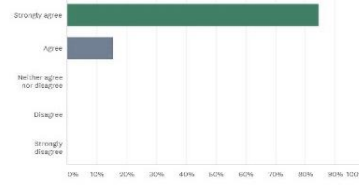
Answered: 40 Skipped: 0



ANSWER CHOICES	RESPONSES
They look softer and provide a feeling of safety	50.00% 20
They seem odd but unique	50.00% 20
I would not live in a circular building	0.00% 0
TOTAL	40

Question-3- Circular Form Concept: How would you consider residential buildings to be according to your own vision and knowledge?

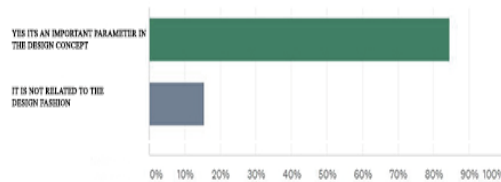
Answered: 39 Skipped: 1



ANSWER CHOICES	RESPONSES
Strongly agree	84.62% 33
Agree	12.79% 6
Neither agree nor disagree	0.00% 0
Disagree	0.00% 0
Strongly disagree	0.00% 0
TOTAL	39

Question-4- Environmental Studies: According to many Architects and studies, round buildings reduce the number of materials needed by 30%. Would you encourage the increase of circular buildings in order to help environment concerns?

Answered: 39 Skipped: 1



Question-5- 360-degree vision: Do you believe that the sensation of sight has a significant part in the design concept of the circular residential building?

5. DISCUSSION

Architects, students and users were requested to participate in an online survey regarding “the circular geometry in residential building” in order to identify common blunders and develop new strategies. Multiple dimensions about the theme and goal might be understood based on the results of the survey mentioned previously.

In terms of the questions posed, the first chart of “Question-1” concerning the expressive form and if the orthogonal interior will be something to approve of, the most gave “yes, easier to furnish “as a common answer, this shows that furnishing a circular plan is not a barrier .Concerning the chart of “Question-2” talking about the resistance of this type of building facing the Earthquakes and winds, most gave positive feedback while this shows the importance of this geometry in such constructions. According to the previos studies and data, round houses are more resilient to hurricane-force winds due to their aerodynamic features. The air blew heavily on the flat sides of ordinary houses in places prone to gale-force winds and storms, eventually destroying them if the gusts are severe enough. The wind against a circular home, on the other hand, is easily avoided. This illustrates that circular plan designs have an undeniable influence due to their visual and symbolic characteristics, which are also new solutions to particular projects. In the case of "Question-3," concerning the circular form concept embracing the circular buildings on how are circular residential buildings considered to be. The results of the survey were as follow: 50% answered that they look odd but unique and the other 50% answered that they look softer than sharp edge buildings and provide a feeling of safety, no one answered that they would not live in a circular house. Traditional houses are intricate buildings with various surfaces. Round buildings, on the other hand, are comparatively straightforward to construct, using fewer materials and less time while giving at the same time a soft and comforting feeling. “Question-4” where the majority of the interviewee gave positive feedback about this environmental question

stating that round buildings reduce the number of materials needed by 30% and if they would encourage the increase of circular buildings in order to help environment concerns. Only 15% gave negative responses, indicating that the majority of them agree with this quotation because it fits in the field of the circular plan and has a logical background. Circular buildings use 20 to 30% fewer materials per square meter than a traditional design, because they have a smaller surface area, they are less expensive to maintain over time. Finally, according to the chart in “Question-5”, the highest number of answers where those circular plans have a 360-degree view, which is true. A 360-degree view gives the building an essential relationship with the surroundings; it is one of the major advantages of a circular plan. In addition to having a significant part in the design concept of the circular residential building. “Circular living creates a mix of looking within and outward, seeing out at the natural environment and surroundings but then coming back in to the self and the hearth”.

Finally, the paper’s aims were to provide the evidence that the geometry of a tiny minority of residential buildings are circular, and it questions why this is so. In addition, it intends to encourage the use of this type of buildings and to propose innovative design methods that can be applied in the circular residential buildings, trying to justify the architectural spaces to fit with the curvilinear walls and the recognition of the advantages produced within such buildings. The main aim for using the circular plan approach for buildings, according to architects, were urban considerations such as optimizing the view, fitting the architectural shape into the environment, and ecological aspects such as energy savings. The efficient use of daylight and the contrast with the surroundings were two other common motivations for developing structures on circular designs residential buildings with circular layouts are no longer prevalent. It is the outcome of design challenges, technology challenges, and construction expenses.

6. CONCLUSIONS

Based on prior research, the study might lead to the following conclusions:

- A. Even if the outside of a building appears to be round, the inside is usually set out in an orthogonal layout. Buildings with central plans and their derivatives are commonly utilized for two reasons: environmental reasons (minimization of external walls while keeping a large floor plan area, resulting in material and energy savings during installation and renovation) and urban justifications.
- B. It considers a novel technique to comprehend circularity difficulties in design projects in a systematic method. As a result, a number of issues were discovered and shown, including building code enforcement, construction complexity, and demolition ease. This research used genuine data to explain circularity issues and provided a new perspective on them.
- C. The findings of the research lead to the creation of circularity-related solutions. Professionals working on the focused projects were looking for innovative methods to incorporate circularity into their work.
- D. The use of a least amount of material while providing the best structural quality of any form. Combining a circular structure with chambers designed orthogonally within is the most successful. A residential building's circular shape provides protection while also guarding against external factors such as temperature.
- E. The total applicability, regularity, and universality are reflected in circular geometry. A residential structure's circular shape protects it from large-scale issues like temperature and earthquakes. The architects benefit from the circle's energy by modifying its form. The circle has had a spiritual, mystical significance from ancient times, and has been used in various cultures' architectural, funerary, and religious plans, with an indication of the planets and other natural manifestations.

Recommendations

- F. Addressed to the Architects: When creating circular plans for residential structures, architects should pay close attention to achieving maximum 360-degree views while fully integrating with the site environment, which means taking into account the internal space and wall designs.
- G. Addressed to the professors: Instead of using rectangular shapes, architecture instructors could incorporate this sort of construction in their lectures to develop new thoughts and forms for future residential structures, because circular geometry has numerous advantages over the previous type.

- H. Addressed to the Architectural students: Architecture Students who wish to create traditional rectangular residential homes in their projects should go outside the box and use creative circular building techniques while taking into account interior functioning and architectural drawings.
- I. Addressed to the businessman's: Customers and managers should no longer be afraid of circular structures. Architects may release their creative thoughts to develop sustainable and innovative shapes for residential structures with solutions for the interior spaces once the financial plan is in hand.

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