CURRENT GLOBAL HOUSING CRISIS SOLUTION: THE PRECAST FRAME STRUCTURE

To give hope to hundreds of millions of people facing housing concerns over the world, from homeless to those struggling to pay rent.

Content **Page**

1. SUMMARY

1. Housing is one of the basic needs of human beings. It is part of its their safety and security needs.

2. This fundamental human need is not however, satisfied for thousands of millions of people around the world, consecutively to a housing crisis currently hitting all countries, from the richest to the poorest. Entier humanity is affected by the crisis.
And there is no prospect of improvement in sight.

3. Although physical support of housing is the house, the way it is manufactured is not put on the table when looking for solutions to the crisis.

4. Concrete is the most used construction material over the world. However, a concrete connection is not fit for the job. Steel connection is a revolution which unlocks the huge potential of concrete in construction, making it the perfect solution to the current worldwide housing crisis.

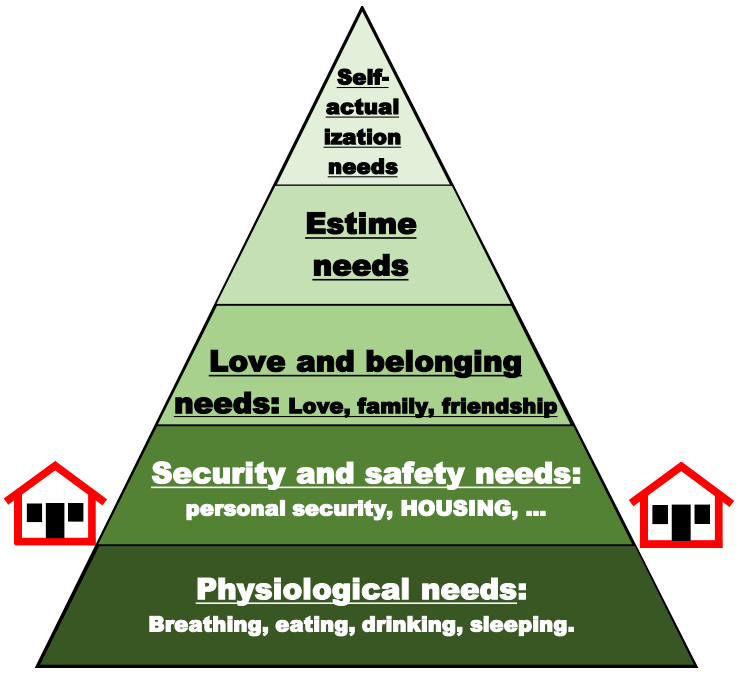
5. The precast frame structure gives a perspective of solution to the crisis. It can be implemented immediately, for quickly and dramatically increasing the offer of houses all over the world.

5. Houses are:

a) Stronger (2 -3 times);
b) Less expensive (0.5 time);
c) Faster in construction (4 times);
d) More environment friendly (2 times).

2. HOUSING IS A BASIC HUMAN NEED

Maslow Hierarchy of Human Needs
One's motivation is dependent on a hierarchy of needs. These needs are organized in a pyramid showing the needs that should first be met prior to higher needs.
Higher needs emerge when people feel they have sufficiently satisfied the previous need.



Maslow hierarchy of needs

When survival needs are met, then follows immediately safety and security needs, including housing. Even before love, family, and friendship.

3. HOUSING CRISIS IN THE WORLD

Currently, there is a severe housing crisis at the global level. It is worsening every day, and there is no perspective of solution in sight.

3.1 Switzerland

“Rents are increasing, the offer of housing is rare, and no perspectives of improvement”.

3.2 France

"The housing crisis is not just for the unfortunate people. Everyone is concerned. »

3.3 Turkey

Between the second quarters of 2022 and 2023, the house prices in Turkey almost doubled (95.9%).

3.4 Canada

“Housing crisis: 9 in one house.”

3.5 Australia

“Australian Housing Crisis Is a Human Rights Disaster”.
“Homelessness is very large in Australia, 120,000 people plus”. (0.4% of the population)

3.6 India

“India is estimated to have a cumulative affordable housing shortage of 31.2 million units by 2023, with a potential market size of Rs 67 trillion” ± $ 800 billion!

3.7 United States

The United States currently has a housing shortage between 4 and 7 million homes.
Nearly 7-in-10 Americans are concerned by rising housing costs.

"We are facing a massive housing deficit".
Even if constructions immediately double, we still need 5 to 10 years just to catch up the current demand."

4. UNDERSTANDING THE BUILDING

The physical support of housing is the house!

People are used to think that a house is a too complicated thing to understand, that even most professionals don't understand too much how it really works.

It resulted in a huge inertia to change and to improve. Hence, inappropriate and outdated techniques for construction in general, and the current incapacity to meet the housing needs at the global level.

To make it simple, buildings are made of 3 components:

1. Structure: Foundation + posts and beams + floors + stairs
2. Walls.
3. Complements: Doors and windows; water and electricity; Insulation and finishing.

5. THE RIGHT MATERIAL AT THE RIGHT PLACE

5.1 What is new?

We took the best from the main construction techniques:

From wood construction, we took the technology: posts and beams, joists floors, stud walls.
From concrete construction, we took the material: reinforced concrete.
From steel construction, we took connections and triangulations.

And it resulted the Precast Frame Structure.

Steel connection in reinforced concrete construction is a powerful game changer, with immediate effects.

It is the perfect illustration of the principle of the right material at the right place.

Its implementation results in:

a) Connections in concrete constructions to be designed as strong as structural considerations may require;

b) Houses to be built in an industrial spirit and at an industrial level.

Huge possibilities of concrete in construction in general, and especially in housing, have been unlocked.

Construction becomes stronger, faster, cheaper, more environment friendly!

The precast frame structure has enough particularities to be a completely new construction technology.

It was invented in Burundi, and patented worldwide:

BI 2015,321; US 10494807 ; US 10837167 ; EP 3310973 ; EA 034805 ; CN 4238807; IN 471248.

5.2 Weakness of concrete connections

They should be a thing of the past.

5.2.1 Connection, crucial for buildings stability

Buildings have to resist to 2 main types of forces: vertical et horizontal forces.

Vertical forces. They are well known: self-weight and occupancy of the building. It is easy to deal with them efficiently: foundation, frame, floors, stairs.

Horizontal forces. They are not well known and are unpredictable. Mainly wind, earthquakes, and construction dissymmetry. They are the most dangerous for buildings.
All structural elements are involved in dealing with them, but connections are on the frontline!

And yet the connections are not designed to meet these challenges.

5.2.2 Connections left behind in concrete construction

Columns and beams are designed to resist vertical forces. Connections are "natural" results of columns and beams designing. A sort of natural children that nobody takes care of.

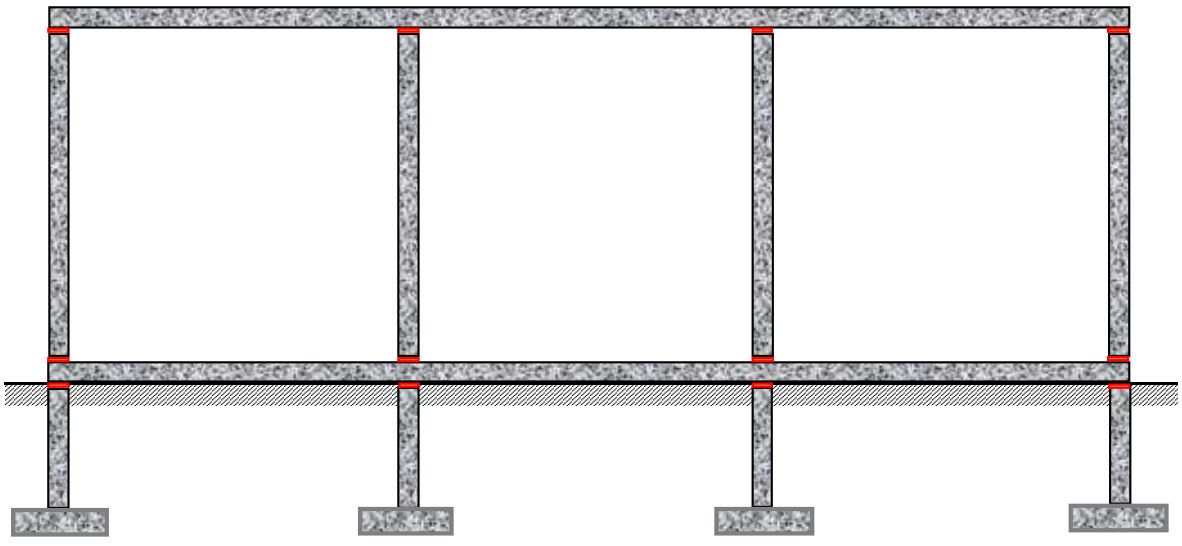
https://www.researchgate.net/publication/245378123

Concrete connections are not designed to withstand important horizontal forces!

The palliative solution against horizontal forces is shear walls. They are walls especially designed to play the role that well designed concrete connections should have played: withstanding horizontal forces.

5.2.3 Illusion of monolithic structures: cold joints

One of the weakest points of concrete construction are “cold joints”, especially at bottoms and tops of columns.
The whole concrete structure is supposed to be monolithic. It means that it is supposed to be made in one piece. However, the whole concrete cannot be poured at the same time. There is no suitable adherence between concrete batches which have not been vibrated together.



Cold joints at tops and bottoms of columns

5.3 The ideal connection material: steel

It's obvious that concrete is the right material for all foundations.
The same should be true with steel to be for all connections, regardless of the material used elsewhere in the building.

5.3.1 Simple buildings

For simple buildings connections are not stressed at an alarming level unless for earthquakes prone areas. Accordingly, wood uses wood connections and concrete uses concrete connections with no special risk, in the structural point of view.

5.3.2 Multistory buildings

Wood construction pragmatically and appropriately shifts to steel connections when “serious things start”.

. The Ascent, USA, a hybrid high-rise apartment building, 25 floors.

. Mjostarnet, Norway, a timber high-rise commercial building, 18 floors.

. Bullitt Center, USA, a five-floors commercial building.

However, concrete construction didn’t adapt. It didn’t adopt the right connection material for multi-story buildings.

6. MAIN FEATURES OF THE PRECAST FRAME STRUCTURE

Introducing steel connections in concrete construction can be assimilated to an act of liberation of concrete construction, allowing it to display its full potential in construction.

6.1 Industrialization of concrete construction

All structural and non-structural elements of construction are broken down into their elemental parallelepiped shape, with appropriate methods of assembling them on construction site.

. Posts and beams for the structure;
. Joists and concrete boards for slabs;
. Stringers, steps and risers for stairways;
. Studs and boards for walls.

It results in industrialization of construction with its lot of advantages: mass production, cost reduction, fire protection, height construction.

This alone is enough to make the technology competitive in all points of view: technical, economical, time for construction, resistant to most disasters (earthquakes, hurricane, fire, etc.). In addition, the technique has a great potential of improvement downstream. It is at its beginning.

	
Precast posts and beams, in mass.	Precast stairways stringers, in mass, etc.

6.2 Impressive cost reduction

6.2.1 Construction of columns

It is 2 to 3 times more difficult to fabricate columns in vertical position on construction site, compared to fabricating them in horizontal position in factory!
We also get there in the end. But why make it complicated when you can make it simple?
Reinforcement cage, shuttering, pouring, vibrating, deshuttering, curing.

https://youtu.be/frxDHxoTNLk?si=XgTbh_REt13Wj9Hx

6.2.2 Construction of beams

It is 2 to 3 times more difficult fabricate beams at 3, 6 or 10 meters in the height at construction, compared to fabricating them at the ground level in a factory.
Reinforcement cage, shuttering, pouring, vibrating, formwork removal, curing.

6.2.3 Construction of slabs

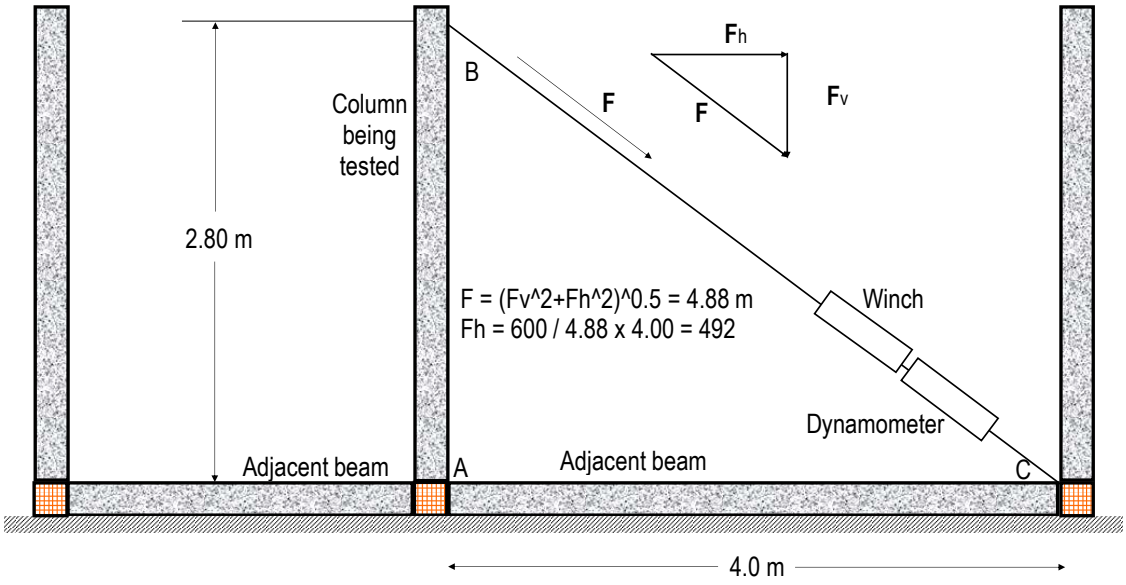
It is 2 to 3 times more difficult to use conventional poured onsite concrete slabs, compared to using precast concrete joists slabs.
Reinforcement cage, shuttering, pouring, vibrating, formwork removal, curing.

6.2.4 Construction of stairs

It is 2 to 3 times more difficult to build stairs using conventional poured on site method, than precasting their elements in factory: stringers, steps and risers!
Reinforcement cage, shuttering, pouring, vibrating, formwork removal, curing.

NB: For reinforced concrete stud walls, competitiveness is to be evaluated in comparison with local alternatives: wood and wood-based stud walls, brick work, fiber cement stud walls, cement blocks, etc.

6.3 A unique moment resisting joint



A force of 500 kg (1,100 lb) is applied to the top of each column on buildings under construction, to prove its resistance to horizontal loads.

6.4 Fast construction

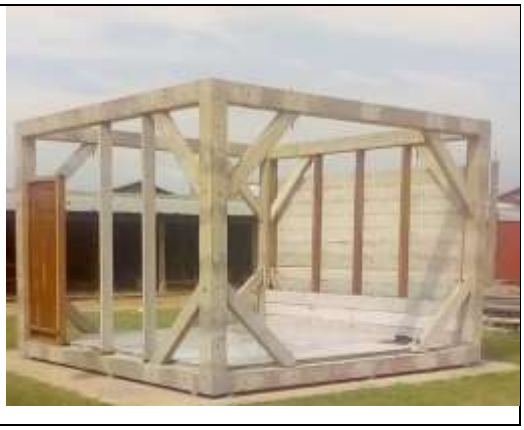
Precast compagnies have available all construction elements ready to be assembled on site: posts, beams and braces; slab joists and boards; stringers, steps and risers for stairways, etc.

A 5-floors, 10 apartments precast frame structure, can be completed in 3 months by 6 welders, 6 laborers, 2 masons and 1 supervisor, winter or summer.

Infill walls, doors and windows, plumbing and electricity, insulation and finishing are not included in this time.

With traditional poured onsite concrete, the same construction will likely take 4 times more time, cost 50% more, and be 2 times weaker!

6.5 Defeating earthquakes

Experts are talking about "**defeating earthquakes**" with triangulated structures like ours, not even mentioning the highly moment resisting connections. https://www.youtube.com/watch?v=Bg4kSIgn67I&t=3s *Min 0-2:45* Moment resisting joints and intensive triangulation make buildings almost indestructible. Even in case of powerful earthquakes or hurricanes, buildings may suffer at the most, of non-structural damages	

6.6 Tidiness and quietness at construction sites

The construction site for poured on-site concrete is generally noisy, cluttered, humid, long to finish, etc. Here, nothing to drill, nothing to cut, to nail, to vibrate, to cure, etc. **Just lifting and welding**. Construction is even more quiet, cleaner, and quicker than wood construction.	

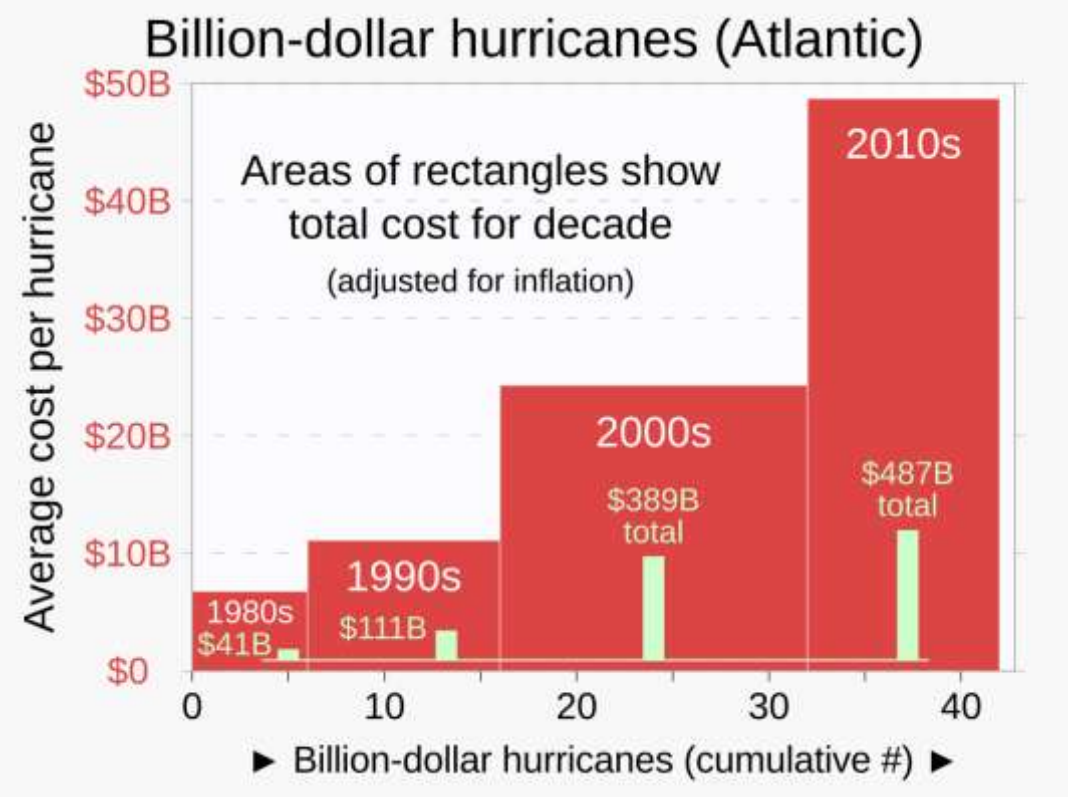
6.7 Important labor reduction

The advanced simplification of the construction elements, their prefabrication in factory, results in a drastic reduction of labor in the domain.

	
Hand crane raising posts on the ground slab.	Hand crane lifting posts and beams from the ground and posing them at the 2nd floor

6.8 Hurricane proof constructions

In addition to moment-resistant connections and intensive triangulation, roof slabs with proper fastening make buildings hurricane-proof.



Wikipedia

6.9 Fire resistant constructions

Everything is precast and fire resistant: structure frame, joist slabs, stud walls, stairways and braces.
Roof slabs provide additional protection against flying embers in case of external source of fire.

6.10 Quick approval for housing projects

Currently each construction and/or housing project is structurally and architecturally unique. It requires personalized analysis before approval.
With precast frame structure, construction projects are structurally almost the same, although architecturally different. In this point of view, the approval process will go faster.

6.11 Other characteristics

- New architectural opportunities, including the ease of creating slab roofs, large openings, and large bay windows.
- Reduced building insurance costs.

7. OBSTACLES TO THE CHANGE

7.1 Reasons specific to the construction domain

The construction industry has a very strong inertia. To reverse any trend, a lot of energy and resources are needed: mentalities; tools and equipment, materials, etc.

7.2 Important conflicts of interest

Some construction players may be driven solely by profit. At this point, the housing crisis constitutes an opportunity rather than a problem for them.

7.3 Technology transfer in the wrong way

The common sens of technology transfer is from North to South. It is not easy to go in the opposite direction. Even in the South there are hesitations to use a technology that not respect the above rule. Despite the evidence, a certain expectation of prior validation by the North is noticeable.

8. FACTORS CONDUCIVE TO THE CHANGE

Deep change in the construction domain requires bold vision and strong commitment from politician actors, scientific communities, media, social stakeholders, etc.
Awareness that meets the challenges relating to the current housing crisis is noticeable among important actors capable of making things happen.

https://www.youtube.com/watch?v=m8bOQR9rvS4

9. ADDITIONAL RELATED TECHNIQUES

9.1 Mixing and kneading of cement paste

To increase the compressive strength of concrete, the best way is to reduce the mixing water: achieving a low water-to-cement ratio. This is generally achieved by adding chemical admixtures such as water reducers.

We achieve a comparable result without using admixtures. We have just borrowed the mixing/kneading technique from bakery production.

"The ingredients are first mixed before being kneaded. Bread dough must be kneaded to for the gluten to develop into long, intertwined strands."

1st phase: water, cement and fine aggregates are mixed and kneaded to form a paste with a good texture.
2nd phase: the paste is added to the coarse aggregates in the usual concrete mixer.

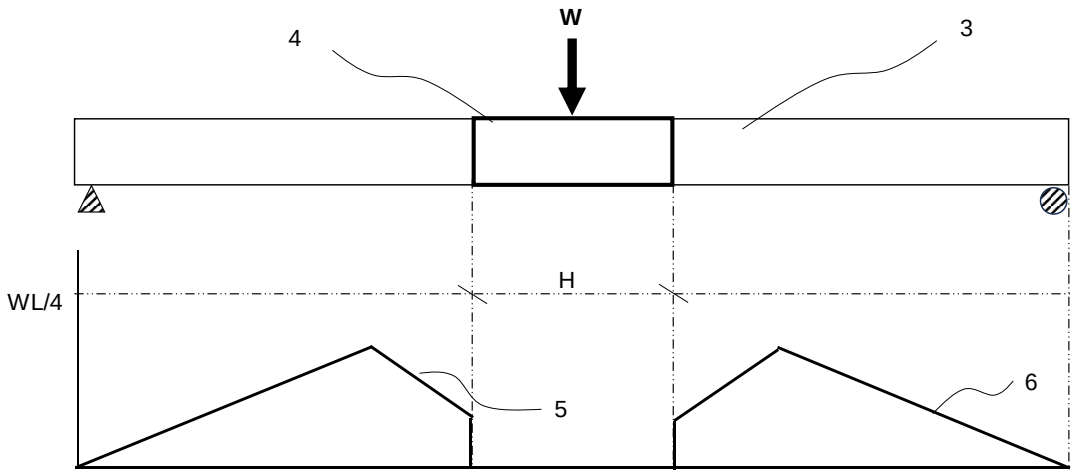
This results in a higher compressive strength of the concrete of around 25%. It is possible to choose to reduce the quantity of cement used and maintain the same compressive strength.

	
Binder: water-cement-sand	Coarse aggregates

Patent application CA 3,100,165 of 20/11/2020.
The application was abandoned for various reasons, but the expertise is available.

9.2 Beams incorporated columns

Beams incorporated columns is a new concept of beams which results in doubling the span between two columns, all other things being equal. Or to reduce the dimensions of beams, and therefore the materials used by around 25 %!



Patent pending: US 63/762,062.

9.3 Next step: prestressed concrete in housing

To adapt the manufacturing process to prestressed concrete, it would mainly just require to reinforce molds so that they can withstand compression during prestressing. The ends of the reinforcements are exposed to the outside to easily accommodate the tensioning device.	

9.4 Heating using thermal convection

In 2024, 30% of French people has suffered from cold in their home. 75% of households say they have reduced heating to avoid high bills.

Heat transfer by convection occurs by the movement of fluids, hot molecules rise upward due to their lower density, and cold molecules move downwards due to their higher density. For example, boiling water in a container
Current heating techniques practically oppose this physical phenomenon of convection, by forcing the hot air to descend to heat the useful space.

The rock of Sisyphus.

Disadvantages:
- This creates uncomfortable airflow;
- The hot air constantly rises through the same convection phenomenon. The energy consumption to maintain the cycle constitutes a significant expense for families and a useless sacrifice imposed to the environment.

- The noise of some hot air circulators and recyclers constitutes a significant noise nuisance.

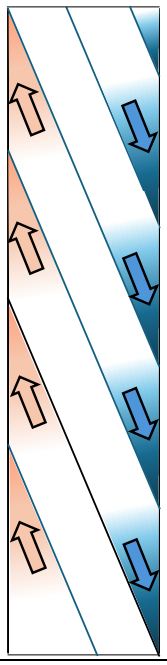
Alternative: Take the cold air from the lowest level of the heated room, from under the bed for example, and deposit it above hot air using a duct and an air extractor.
The temperature is harmonized in an extremely silent way, without any uncomfortable air flow, and with a minimum energy consumption.

A small portable travel device allows to increase temperature by 2°C after running it about 10 minutes!

Heating is part of housing. Simple devices appropriately designed may reduce the percentage of people suffering from cold, from 30% to 20% for example.

International Application PCT/IB2001/001271, AU 2001272687
Application was abandoned for various reasons, but expertise is available.

9.5 Isolating using thermal convection

Air is the most used gas in insulation. If left free in the insulating space, it will move around consecutively to the phenomenon of convection, and then transfer heat. To maintain it almost stationary, it is usually enclosed in tiny pockets of fiber glass, mineral wool, silica aerogel etc. The new method is using geometrical arrangements to prevent convection, or to make it uneasy at a so large extent that heat transfer will take place through air. This new method is more effective, especially for door, windows and other glazed surfaces. Patent pending: US 63/766,614	

10. CONCLUSION

1. The housing crisis is real, severe, and global, affecting every country in the world, from the richest to the poorest.

2. As things currently stand, there is no prospect of improvement in sight.

3. Since the physical support of housing is the house, a large part of the solution lies in ways it is constructed.

4. Actually, the construction domain has not yet undergone its industrial revolution.
That is why it is currently unable to effectively respond to the housing crisis.

5. The precast frame structure is a major step towards the industrialization of construction. It therefore represents a great opportunity to deeply, quickly, and sustainably change the situation in construction, and therefore in housing.

6. Additional related techniques contribute to making housing even more accessible and more pleasant to live.