



HOUSING CRISIS SOLUTION: THE PRECAST FRAME STRUCTURE

**Giving hope to hundreds of millions of people facing housing concerns
over the world**

Summary

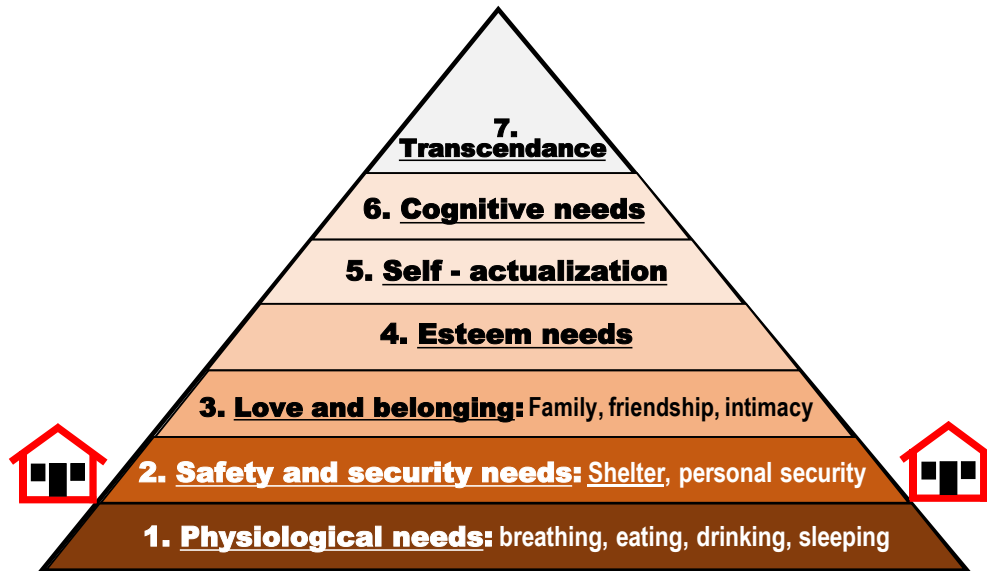
- 1.** Housing is one of the basic needs of human beings. It is part of its their safety and security needs.
- 2.** We are currently experiencing a severe global housing crisis. And there is no perspective of improvement.
- 3.** The physical support of housing is the house. However, when looking for solutions to the crisis, the way houses are manufactured is not given priority.
- 4.** Concrete is the most used construction material over the world. However, concrete connections are a technological disaster. Introduction of steel connections is a revolution which unlocks the huge potential of concrete in construction.
- 5.** The precast frame structure gives a perspective of solution to the current housing 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).

1. Housing is a basic human need

Maslow pyramid of 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

Needs are arranged in a hierarchy in terms of their potency.

The lower the need is in the pyramid, the more powerful it is.

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

2. Inventory of housing in the world

Currently, there is a severe housing crisis, global, and worsening every day.

1.1 Switzerland

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

1.2 France

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

1.3 Turkey

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

1.4 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!

1.4 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.”

3. Simplifying buildings understanding

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;
2. Walls;
3. Complements.

Structure: Foundation + frame + floors + stairs + roof.

Complements: Doors and windows; water and electricity; Insulation and finishing.

4. The right material at the right place

4.1 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.

Steel connection in reinforced concrete construction is a powerful game changer.

It is a perfect illustration of the principle of the right material at the right place, allowing concrete connections to be designed as strong as desired. And more importantly, allowing to start making houses at an industrial level.

Huge possibilities of concrete in construction in general, and in housing in particular are 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.



4.2 Concrete connections are a technological disaster

They should be a thing of the past.

4.2.1 Connections performance is crucial for building 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 unknow and unpredictable: wind, earthquakes, construction dissymmetry, etc. They are the most dangerous for buildings.

Any construction element is involved in dealing with them, but especially **connections!**

4.2.2 Concrete connections are left behind in designing

Columns and beams are designed to resist vertical forces. Connections are just the intersections between those columns and beams. What is good for them is also good for connections.

Concrete connections are the poor cousin of buildings design. They are just subject to columns and beams design. And yet they are at the frontline to oppose the most dangerous forces for buildings.



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

Concrete connections are a technological disaster!

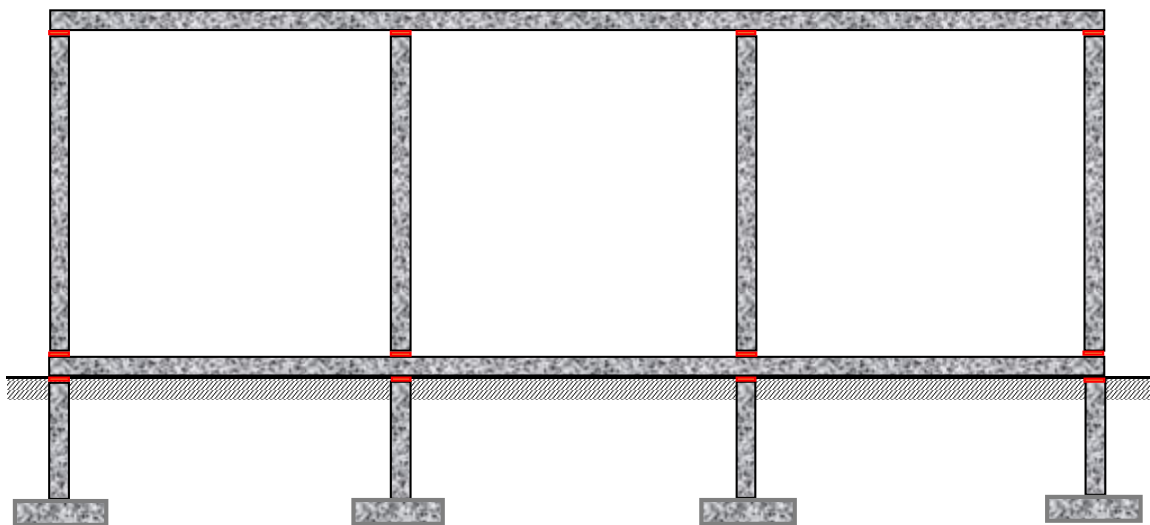
The palliative solution against horizontal forces is shear walls. They are walls especially designed to play the role that well designed concrete connections should have played: opposing horizontal forces.

4.2.3 An 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 moment. There is no adherence between concrete batches poured at different periods of time: they are called “cold joint”. Between concrete batches which have not been vibrated together, a cold joint is created.

They make concrete connections even weaker, and unable to help building resist to horizontal forces.



Cold joints at tops and bottoms of columns

4.3 Steel is the most appropriate material for all connections

The same way concrete is indisputably the material for all foundations, steel should indisputably be the material for all connections, whatever material is used elsewhere.

4.3.1 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.

4.3.2 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. It was built using steel in connections between vertical and horizontal construction members.

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

However, concrete construction didn't adapt and make similar change for multi-story buildings.

5. 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.

5.1 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, etc.

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.



5.2 Important reduction of cost

- It is 2 to 3 times easier to fabricate a column in horizontal position, in factory, compared to manufacturing it in a vertical position, on construction site!



- It is 2 to 3 times easier to fabricate a beam at the ground level, in a factory, compared to manufacturing it at 3, 6 or 10 meters in the height, at construction sites!



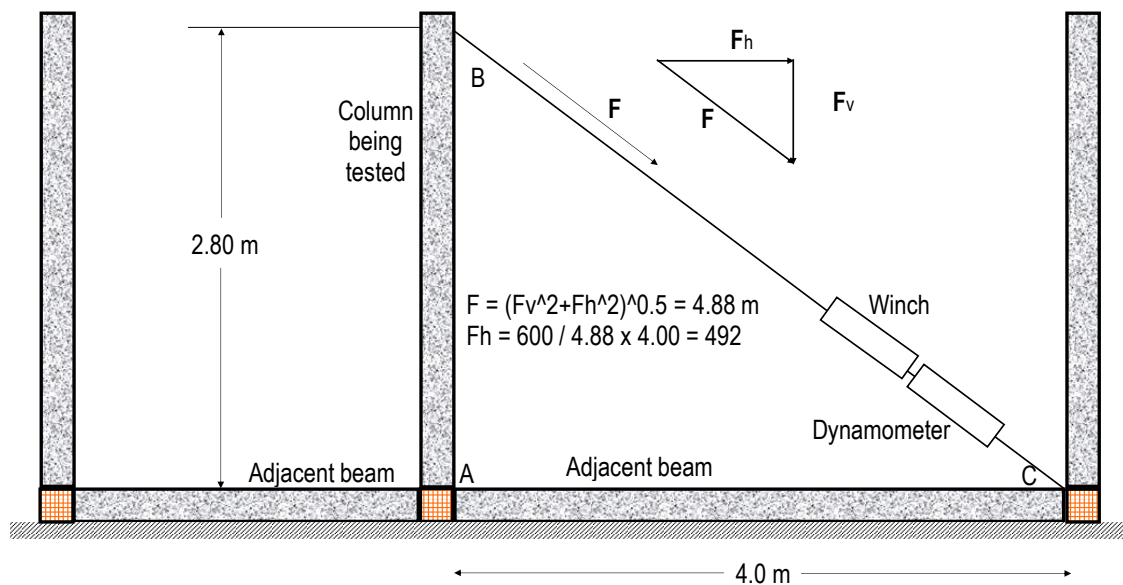
- It is 2 to 3 times easier to use precast joist slabs, compared to poured onsite conventional slabs.



- It is 2 to 3 times easier to use stairs with precast stringers, steps and risers, compared to using conventional stairways, poured on a construction site!

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

5.3 A unique moment resisting joint



A force of 500 kg (1,100 lb.) is applied on top of columns at 2.8 m (9.2 ft.) on each building under construction. All other things being equal, very few, otherwise none contractor would accept to make such a test on a building under construction.

See paragraphs above on cold joints no design of concrete connections.

The same way steel connections have allowed the construction of high-rise timber buildings, steel connections in concrete construction is a game-changer which results in impressive fallouts.

5.4 Fast construction

Precast companies 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!



5.5 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=Bg4kSlgn67I&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



5.6 Tidiness and quietness of 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.

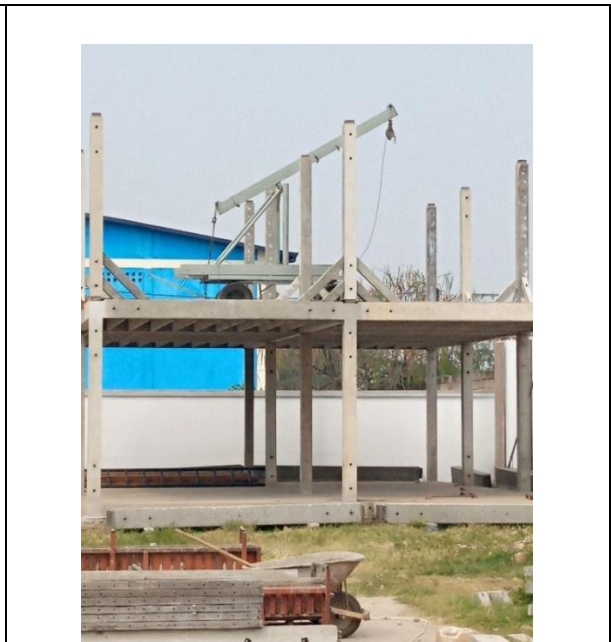


5.7 Reduction of labor

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. Foldable mini tower cranes may be considered for a quicker construction



Hand crane lifting posts and beams from the ground and posing them at the 2nd floor

5.8 Hurricane proof construction

In addition to moment resisting joints and intensive triangulation, roof joist slabs make buildings hurricane proof.

5.9 Fire resistant houses

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.

5.10 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.

5.11 Other indirect advantages

Home insurance cost reduction.

6. Obstacles to change

6.1 Structural reasons

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

6.2 Important conflicts of interest

When majority of stakeholders are guided solely by financial profits, the housing crisis is not a problem in itself. It is even an opportunity for them.

7. Factors conducive to change

Deep change in the construction sector requires bold vision and strong commitment from politician and administrative actors, scientific communities, media, social stakeholders, etc. Awareness that meets the challenges relating to the current housing crisis is noticeable all over the world.



<https://www.youtube.com/watch?v=m8bOQR9rS4>

8. Additional related techniques

8.1 Reducing water/cement ratio without admixture

To increase the compressive strength of concrete, the best way is reducing the mixing water: low water/cement ratio.

This is usually achieved by adding chemical admixtures such water reducers, etc.

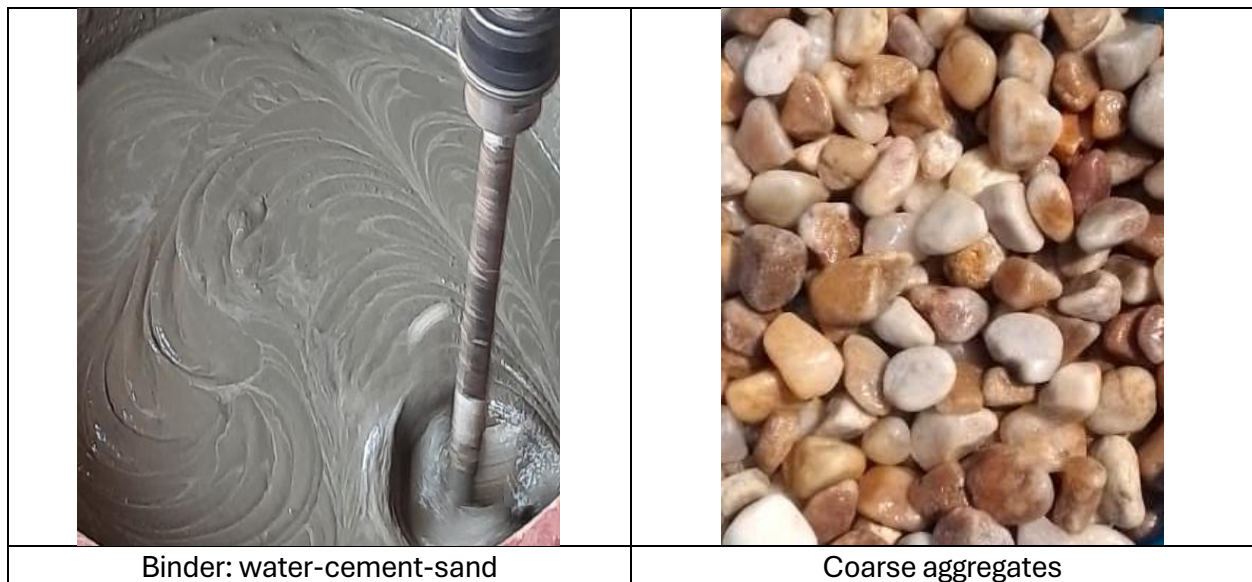
We realize the same purpose just by changing the order of mixing concrete components.

Usually: Aggregates + Sand + Cement + Water.

New method: Water + Cement + Sand + Aggregates.

It results in:

- . Important water/cement ratio reduction;
- . Concrete compressive strength increases by $\pm 25\%$;



Specimen reference	Specimen mass	Braking force	Section in cm ²	Compressive Strength	Cement dosage in kg/m ³
No 79	19.26 kg	1330 KN	400 cm ²	33.25 MPa	250
No 80	19.30 kg	560 KN	400 cm ²	14.00 MPa	250
No 81	19.32 kg	930 KN	400 cm ²	23.25 MPa	250
Average				23.50	
No 88	19.25 kg	1540 KN	400 cm ²	38.50 MPa	350
No 89	19.24 kg	1810 KN	400 cm ²	45.25 MPa	350
No 90	19.35 kg	1520 KN	400 cm ²	38.00 MPa	350
Average				40.58	
No 92	19.36 KN	1490 KN	400 cm ²	37.25 MPa	450

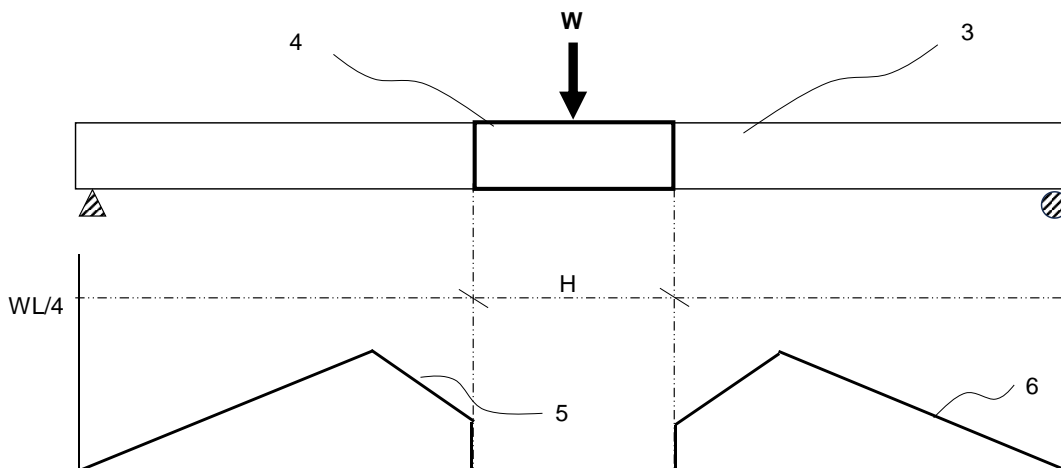
No 93	19.40 KN	1520 KN	400 cm ²	38.00 MPa	450
No 94	19.31 KN	2140 KN	400 cm ²	53.50 MPa	450
Average				42.92	
No 96	19.35 Kg	2020 KN	400 cm ²	50.50 MPa	550
No 97	19.44 Kg	1540 KN	400 cm ²	38.50 MPa	550
No 98	19.45 Kg	2350 KN	400 cm ²	58.75 MPa	550
Average				49.25	

Patent application CA 3,100,165 of 20/11/2020.

The application was abandoned for various reasons, but the expertise is available.

8.2 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.

8.3 Heating using 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.

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.

8.4 Thermal insulation by air 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

