Residential Complex

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The role of identity in urban texture and architecture

The first image come to mind talking about a big city definitely includes wide streets and highways full of traffic and rows of high rise buildings! London, Tehran, New York City, Beijing… The question is what is this prototype urban look that we are applying everywhere?

Beijing, china, far east

New york, u.s. , america

London, England, europe

Tehran, iran, middle east

Sydney, austrailia.

The similarity of the resemblance between these cities is too disappointing. Except some landmarks they can be as well all pictures of the same city! They are far from any respect for their residents diverse cultures, history, or even their daily life. These walls don’t tell you any stories of the people living among them. I wonder how people can call it their home or their office. This kind of copied non unique environment sadly doesn’t embed any sense of identity or belonging. Where we are going by this architecture, as high-tech and ambitious as it looks like, we are in treat for a global homogenous city, Widen from west to east! There would be no uniqueness to the rush and vibrancy of New York City, no classy spirit or poetic environment of London, and no sign of rich eastern culture on the roofs of china, just high-rises piercing sky everywhere. Do we really want to live in such a world in the future?

An urban environment gets its sense of home town by its memories in the walls of its built environment. A wall does not only exist to define a space but its supposed to define the space by all its characteristics. Unfortunately in Tehran like so many other capital cities in the world life has a high speed and "new" is what really matters. But the solution is not to demolish buildings every decade. Yet it is to bring new technologies and refurbish what we already have.
in the "darabad", the project site and its surrounding, there are some touch of good old days left. Which are consider as a plus for the area. Its not as old to be an architectural heritage or not so artistically mater pieces of architecture. But yet they bring certain characteristics to the area. The mosque which is the first functional icon in every area and the small little 1 or two storey houses around it, some little old style food shops in narrow allies which are only wide enough to walk through are the main features representing the identity of the area. And from them the story starts…

This is a picture from the area around, the mixture of old and new is abvious. The hights of the buildings usually does not exceed than 5 stories. And the nature is highly integrated while the built environment is not dense.

The area is very topographic and there are signs of new construction every where. specially on the foot hills.

The old days spirit is quite strong, in the style of shops, the wide windows, and the material used in the buildings. And vegetation is almost in every view.

The entrance of the urban site, on the left there is the mosque and some small old buildings, on the right the foothills and the river.

the effective green space in architecture

its clear that We all know the green space is essential to our living environment by today. Parks, green landscapes, here and there some flower box hanging on a balcony or any other minor diversity of green space is what we have accomplished to keep as a souvenir from nature in our built environment. But the question is how important is the role of green space? And are we green enough in an effective way?

The effects of the green space in our living environment:

1. the green space brings several important ecological service function: regulation of urban micro-climate, reduce storm water runoff, carbon sequestration effect of reducing air pollution, energy conservation, etc.
2. nature is surprisingly beneficial for the brain. Studies have demonstrated, for instance, that hospital patients recover more quickly when they can see trees from their windows, and that women living in public housing are better able to focus when their apartment overlooks a grassy courtyard. Even these fleeting glimpses of nature improve brain performance, it seems, because they provide a mental break from the urban roil.

Well In these recent decades in regarding to realization of importance of green space some concepts improved, such as greenbelt, greenways or green infrastructures.

A greenbelt is a policy and land use designation used in land use planning to retain areas of largely undeveloped, wild, or agricultural land surrounding or neighbouring urban areas. Similar concepts are greenways or green wedges which have a linear character and may run through an urban area instead of around it. A green belt is basically an invisible line that goes around a certain area, stopping people from building there so that some of the wild and agricultural land can be saved. Green Infrastructure is a concept originating in the United States in the mid-1990s that highlights the importance of the natural environment in decisions about land use planning. In particular there is an emphasis on the "life support" functions provided by a network of natural eco systems, with an emphasis on interconnectivity to support long term sustainability. Examples include clean water and healthy soils, as well as the more anthropocentric functions such as recreation and providing shade and shelter in and around towns and cities.

But the concern of creating green spaces does not only limit to its existence or amount of land. But what matters most importantly is the effectiveness of it. in order to benefit from a green space it first must be close, viewable even touchable.

What we see in the picture below indicates a vast green space next to the built environment. But how is that going to work if the view catching the eyes of residents would not include it! This way the green space would just be as far as in the pictures! It doesn’t play any role in the surrounding environment of the people who are not walking by it!

But this is what there is to where citizens live, work or spend most of their time…

This is what could be considered as a mono effectiveness green space in a city. people can only benefits from it when they take time to be in it. these kind of isolating green spaces gives a leisure meaning to green space. a side dish to the city life while the Green space is indicating our nature, our origins. and its the key to a healthier, happier and more beautiful life. A green park is good but not enough, The green should grow out and in of every little bit of our living environment.

Horizantaly and verticaly branches in our every day life.

Having built spaces Strongly integrated with the built environment could be beneficial in functional and sustainable means.

The trees could provide shades and transform sunlight to a desirable light physically and psychologically.

In the “darabad” area which is nearly on the foot hills of alborz mountain, nature it’s the highlight of the environment. Exceptional of other urban spaces there is more nature than the built environment in this region. The beautiful mountains view at the end of the site, the green hills on both side, the rows of green trees of the preserved camping site and the river are the unique features of this almost suburb urban area. the urban design is cantered around the nature. The main axis in the planning is the nature and its growth. The street is following the side of river bed. And the green treed area in the middle is dividing the whole site in to two parts. The Right side is specified to public functions, specially since the mosque which is always the most important iconic building in every locality in an Islamic city is located on this side. and on the left is the residential part, more quite and less traffic. The two areas share the nature of the site in the middle.

Even by placing the street, the existing trees weren’t moved away, yet made a parking border area on the side of the street.

The green axis in the center of the site.

 the green reaches every alley and penetrate built environment

 the rows of trees on the side of the street

 the street at the end turns to pedestrian follows up to the hiking trail


the river

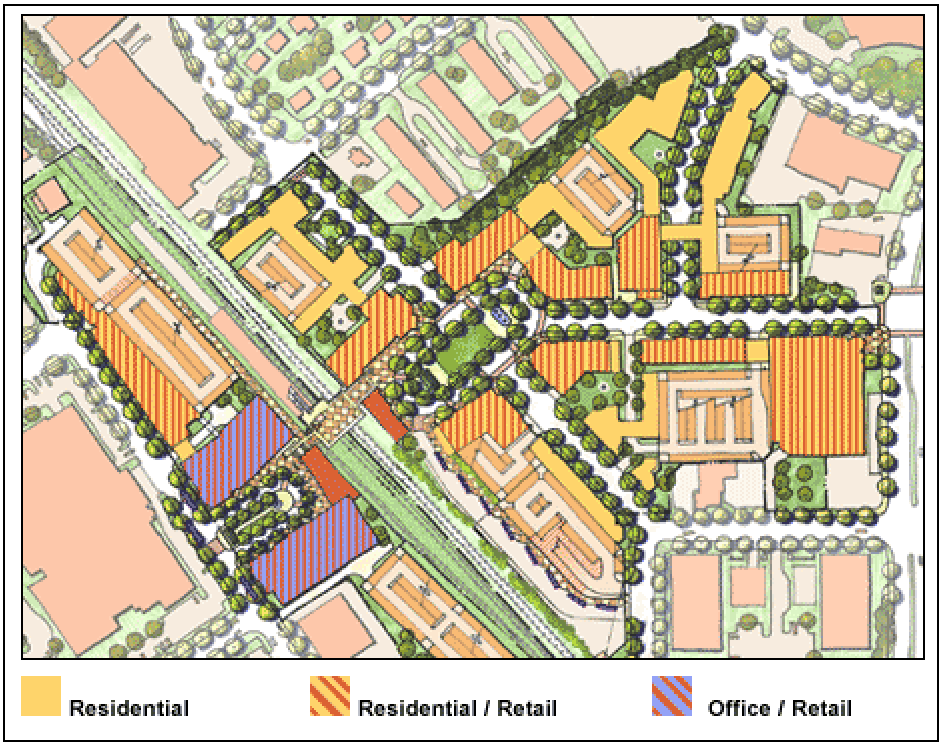
Solutions to Sprawl:

poorly planned development of cities and towns, is widely known as "sprawl." "People are locked in traffic, spending two hours a day driving, and wondering: Why do I live in the suburb?" says environmental scientist William Honachefsky. As population growth fuels soaring demand for housing, roads, and related services, millions of people see the effects of sprawl paving over the natural landscape and eroding the character of their communities.
The world Desperate for solutions seeks new concepts for urban planning such as "smart growth," "new urbanism," and "sustainable cities." Their visions and goals differ according to local conditions. But the intent is the same: to change present patterns of local land use and development. Urban sprawl affects both urban and rural Ontario. Decreases air quality, endangers source water resources and contributes to climate change. Municipalities pay considerably more to service low-density communities than high-density ones. The Green Party asserts that we need communities where you can live where you work, walk to essential services and take efficient rapid transit for longer trips. The time has come to stop urban sprawl. to build communities that cost less to service, create a heightened sense of neighbourhood and counter negative development effects such as pollution, gridlock and long commutes.

Tehran, daily traffic

When you consider how much of the world's population lives in cities and their surrounding areas you realize how important is driving to a convenient and functional urban growth. In 1800, a little more than 2 percent of the world's population lived in urban areas. By 1900, that number had grown to 45 percent. And by 2010, it is expected to grow to 51.3 percent, according to the United Nations. So it might equally mean 50% more traffic, energy, time and summarised in one word more “chaos”.

Its absolutely rational that people prefer to live in a space where they have more facilities. This all started due to the need of living close to daily needed functions. The more access to all the required functions, made city life denser and denser every day. People reached to cities to have a better condition of life. But these days the density reverses the whole process and meaning of living in a city.
Tehran is a crowded city, by day the population reaches to 17 million. It has been constantly sprawling and growing in the past 10 years. At rush hours it’s possible to stick in traffic for at least 2 or 3 hours. The pollution in winter rise up to dangerous levels which results in closing schools. What seems to be the solution is to respond to the “living in a city ambition” in smaller areas as much as possible, so at least the need of transport would reduces.
Smart growth is an urban planning and transportation theory that concentrates growth in the center of a city to avoid urban sprawl; and advocates compact, transit-oriented, walkable, bicycle-friendly land use, including neighborhood schools, complete streets, and mixed-use development with a range of housing choices. Smart growth values long-range, regional considerations of sustainability over a short-term focus. Its goals are to achieve a unique sense of community and place; expand the range of transportation, employment, and housing choices; equitably distribute the costs and benefits of development; preserve and enhance natural and cultural resources; and promote public health.



the public transport has been developed a lot in the past few years, which helps to the traffic a little bit. But nothing has been as much effective as lunar cities. Huge city like residential complexes where most of daily activities are provided. Schools, shops, food markets, even resturaunts can be found in these kind of residential complexes. It’s a very important matter what kind of functions are provided to these complexes, cause easily can result in the failure of use or effect the life style of residents or even turn into an ordinary residential complex instead of a lunar city.

In “darabad” area there are two hospitals and a medical institution, there fore already the job opportunities are fairly provided. With enough residential and retail grounds the growth is nearly smart. But why stop there?

A proper environment is the one which encourage its users towards a better life. The new urban designing municipality rule book explain that each residential area needs to be provided with enough educative, cultural and leisure spaces.

The minimum regular activities people might do during a day:

- eating
- exercising
- shopping
- working
- educating

the aim is to provide as much of these functions possible in the area, mostly in walkable distances. A side from the daily functions each urban area would be unique and successful when it has a specific character which makes it standing out and known by. This region already holds the beginning of a hiking trail which has been dominating it, adding the hiking club intended towards this aim. The spaces were designed mostly pedestrian to stay in harmony with the natural sportive spirit of the area.

the start point of the hiking trail, abandoned and without any definition. It needs to be improved and dominated.

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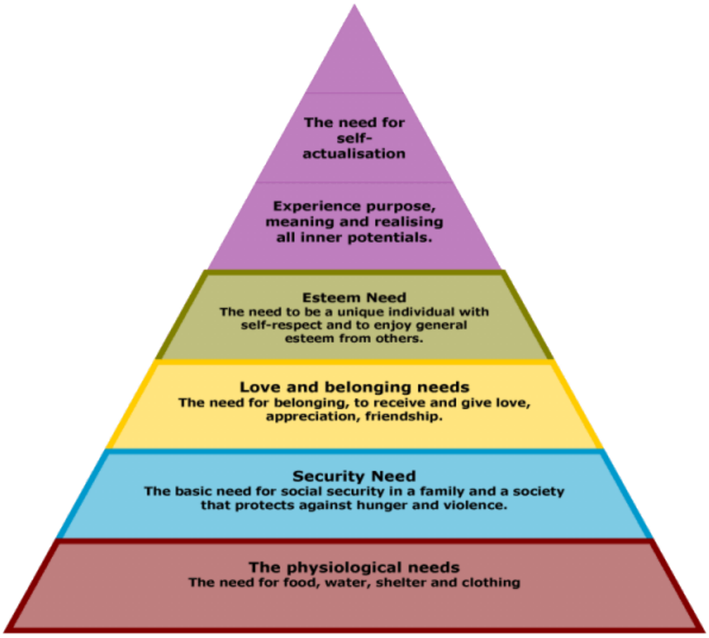


The pyramid of life is a very known way to show the needs of human beings and the proiority of them, designing an urban area should follow the same proportions accordingly:

1. living spaces and shopping area (food and clothing)
2. defining borders of private and public spaces would create a sense of security
3. design with human scales, according to people's background and life values bring a sence of belonging
4. Designing spaces encouraging this generation to direct socializing and anti-shy could help with the esteem.
5. lay options for users to benefit from day time activities in better directions. For example an urban area with a focusing on a mall as its public common entertaining space, would limit the choice of spending free time or meaning of fun for the people of that region subconsciously to shop and eat, while you can improve the society level by providing more diverse and cultivating public areas, such as open temporary exhibition areas, or an art performance centre.

In the urban plan below the areas coloured in relation with the pyramid of life:

Keeping a true sustainability:

Jeffrey inaba the urban theorist and architect writer says that “projects said to be sustainable” often receive "less scrutiny" than projects not so described – which has one particularly disturbing side-effect: sustainable development becomes one of the easiest ways to produce what Inaba calls "regressive urban environments" – with the full support of people who consider themselves architecturally progressive.
A "sustainable" high-rise, for instance, can very quickly get away with being stylistically uninteresting, contextually insensitive and nothing more than a get-rich-quick financial scheme thrown up on the horizon by billion-dollar property developers in New York, London, Dubai, Miami, and so on.
But it's "green," so no one says anything – except to hype it, pointing out that the building has a few solar panels.
but the truth is it really would boost a built environment spiritually and energy consuming wise to hold a touch of sustainability.

The sustainable issues in this urban area:

1. Keep the area mostly car free and pedestrian.
2. Widen the existing river bed and add a branch in order to use its cooling and air conditioning effects, also design water elements in public areas.
3. Use the shades of the trees in the design.
4. Keep a high green ratio.
5. The wind catchers designed to function as cooling system of the residential complex.

Successful urban spaces

An urban space commits fully to it’s concept when it would appear functional and useful to the city and it’s residents. So in order to improve urban spaces we need to find out how people spending time in urban spaces, and how the urban space responds to them. “The Social Life Of Small Urban Spaces” is an informative book which was of course a transcription of many written, photographic, and filmed records of how people actually use public space.
On this film first the activities of people in a piazza was studied. you would be surprised to know that the most popular activity was just watching people, Mostly without even any socializing! People spends hours watching other people, in groups or alone. This fact was followed by the conclusion that the urban spaces with a vista through the current life and vibrancy of the city (like a plaza just by the street) where there is a passing crowd are more used. On the other hand these kinds of spaces are better seen by passers and attract more people in. The separators from the street are usually the turn offs!
As the connection of the street with the built urban space is very important, A level difference for an urban space is really a critical matter. Usually 3 or 4 steps can make a good and attractive invite, while a totally different level would totally kill the connection with the city. Another successful urban space could be arranged like an amphitheatre. Some steps going down make a show out of the

space and people in it! even an indoor piazza respecting to the climate conditions could be a successful urban space while the connection of it would be visibly and accessibly strong with the street. Streets are like the live rivers that pour in the crowd to the space.
Speaking of show, researches show that the street shows in spite of what common concepts are, actually have a good influence on an urban space. Even if the show is not meant to be a show, like a drunk or an insane person, it seems people need to see the insane to feel secure about the sane of them self!
Another kind of sane attraction could be triangulation. Sociable elements could be either an interesting and surprising open window through an interior or an interactive eye catching statue. Food stands and kiosks are people magnets too! After all one of the common uses of the urban spaces are to sit and eat or drink.
Studies have shown that people like to sit where there is a place to sit! There fore the sitting spaces in an urban space effects a lot on the quality of it. a bench is a common sitting furniture in the outdoors, but they do isolate people and limit them. So they are not very likable by people. The important key is to let people sit close yet keep the social distances enough. It's possible to direct the crowd in filling urban spaces by built in sitting spaces or sitting sculptures. On the other hand giving people the freedom of locating is another amazing attraction. Statics shows that in a plaza with movable furniture, 90 percent of people moved the chairs before sitting, even though it was only for some centimetres! Having a choice gives one person the ability of marking his decision in an space. There fore it is desirable. Grass and plants can be a dual functioning component in an urban space. First simply because green is essential for any urban space and second because they can be used to sit or lay.
Nature can be very effective in an outdoor space, a video running the whole day from a piazza in the middle of New York shows that people stay or move to parts of the piazza where there is sun, and this is not only in winter but its true the whole year. Of course when your options are limited you can only provide the light, either direct or reflected by the help of other surrounding built environment. In the other hand, although trees cause shades but people always like to sit under them. They make a sense of a cave, safe and protected. Another reason might be that they define the space, like a ceiling or overhang.
You might be surprised that people will never stop in the middle of a large space, sit, talk, or hang out. They need some definition of the space maybe even some steps or edges. Spaces need to be comfortable in size, and proportional to the intensity of the crowd. Last but not least is the element of water. It's well achieved by people. Specially if they are interactive. They are beautiful to look at, playful for children and even adults, their sound is soothing and a filter the disturbing noise of the city, and they improve the quality of the surrounding air.
At the end to summarise a successful urban space needs to be proportional, well defined, fine entranced from the street, challenged and interactive while have some sort of eye catching icon.

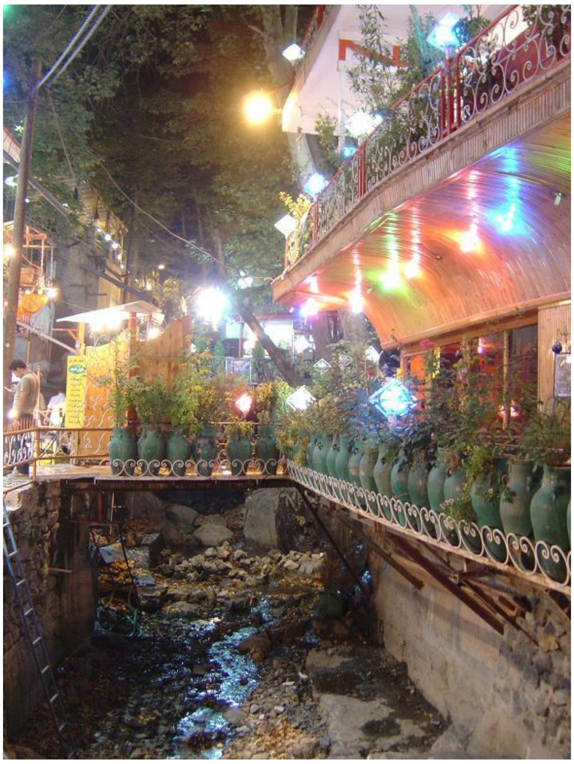
Examples of successful urban spaces in Tehran:

as we said quality of a n urban space depends on its popularity, there fore in addition to all the principles that we mentioned there is one more important matter that influences an urban space and that is culture. a city and its spaces should be most importantly in harmony with the culture of its citizens. For example Tehran, my city, the city that this project takes place in, is a huge city with nearly 12 million citizens. But you might not be able to find a proper plaza any where in it. its surprising! But its simply because it wont work. Citizens in Tehran are not the type who would take a lunch break and go sit out side to eat, or they don't have the habit to sit outside in an built environment and drink. So a space like plazas might not be that much of a use. In the other hand a city like Rome is so popular and famous because its amazing piazzas! So its obvious that after all

the common principles we have to consider in mind while designing an urban space we have to also think of cultural issues.
So I pop the question here; where are the preferred and popular kinds of public urban spaces in a city like Tehran?

Darband

One of the oldest popular urban spaces in Tehran is darband. Its almost full any time of the week regardless of the season and people from any type gather there, Old, young, families…basically darband is a 250 trail with Water falls, few streams, and lined with cafes, kebabs, and beverage stalls, which is originally the beginning of a very popular hiking trail into the Alborz mountain Tochal, which towers over Tehran. Darband was formerly a village close to Tajrish, Shemiran, and is now a neighbourhood inside Tehran's city limits. so most part of it is only pedestrian and cars cant pass. A river passes by in the middle and there is a narrow pedestrian way goes all to the top between these cafes and restaurants, some playing live traditional music, built spectacularly on top of the river and on the steep. You can find people just taking a walk or laying on the traditional beds while eating some Iranian traditional food or kebab, some just lay and smoking some shisha. Some groups are just hanging out, having some fruit treats, nuts or grilled corn and enjoying the fresh air. It is full of liveliness and great smells, also great colours. I sometimes miss the sounds of the sellers shouting to advertise their goods.

Specific Space characteristics:

its a mix of nature and vernacular building environment, there fore its in contrast with the city texture.
its partly pedestrian trail which is attractive in such a mechanized city like Tehran.
Dining is a very special part of people's life in Tehran, and being able to eat something at any time of the day is an important attraction.
Diversity in the space, different heights, different views, and different spaces to sit is another plus for the urban space.

Khaneye cinema

The home of cinema, is best in it's own type of spaces. It has become very popular in the last decade to open the old traditional houses left in the northern Tehran to public, dome of them used to belong to famous people, such as house of dr hesabi. These spaces usually have a beautiful garden which people can take walks or just sit, they prefer it to parks, because they are smaller with walls around it. There are one or two cafes in the garden which usually are very busy so while u write your name to get a table you can walk around the garden. They contain one or two small shops, mostly selling artistic crafts and jewelleries, or movies, or music cd.
In the case of home of cinema, there is a small cinema in the located in the middle of the garden in the old building where they put on very rare and special shows or time to times movies or an exhibition related to cinema and history.

Specific space characteristics:

it has a mixture of open and natural environment and heritage built environment and culture.
small portions of snacks and healthy juices are available any time of the day.
It’s a place that people could spend a considerable amount of time doing some diverse activities without needing to change location with the car and sticking in traffic.

<u>Golestan commercial mall</u>

Golestan has been one of the oldest most popular shopping centres in Tehran. Its actually one of the first malls in the city. For a while people used to go there even though they didn’t want to shop, just hanging out in the yard of the mall, and socialising. Some people used to stay in their car and spin around the area and sometimes park on the side of the street to meet and greet their friends or other people. These days there are many malls in Tehran and the crowd has been balanced in all. The characteristics of mall are pretty common, places that we shop, eat, and hang out. But still golestan used to be in particular in one aspect which was the outer space of it with fountains and dinners around.

Specific characteristics of space

A diverse variety of functions: shopping, eating, socialising, spending time outside.
Open through the whole day till late, and at any time of the day the crowd was there since there was an activity going on.
It was the first in its own type.

Interviews

After all, the main users of any urban space are the residents of that city. so I think in order to design a proper urban space which supposed to service to the society I should hear what that society desire at the first place. Cause at the end an urban space is considered successful if people live in it happy.
I arranged a simple interview with some residents of Tehran raising only one question:
 - Where in Tehran do u consider a successful public urban space? and why?
The whole aim is not to look at it in an architectural point of view, but a common perception. what we have to realize is that the urban spaces are supposed to be used by people and not just look good in architecture. so what i am seeking for is what really attracts people. I would like to mention some of the answers in here and translate some of them into required urban characteristics.

Nastaran rezaee 25, computer engineer, from Tehran

well many places have been successful and each is appealing to a certain segment of society... for instance fereshte & elahie (2 famous regions in Tehran) has been successful in attracting rich people in my opinion simply cause the prices in restaurants, cafes and shopping malls are higher and the upper class (in terms of income) in Iran is fond of luxury and show off. Golestan shopping centre attracts almost everyone as it is one of the biggest malls in Tehran and people can go there to window shop, shop, eat, hang out, etc. Or Tiraje which is both a commercial centre and an entertainment centre (i.e computer games, bowling etc). But in my opinion one fact about Tehran and generally Iran is that we have very few choices of entertainment and such a huge population who is really in need of entertainment, so the fact that many of these places have been successful in terms of attracting people is not because of the quality of their service or ambiance, it's merely because the competition relative to demand for such places is very low and almost all public places have an adequate to high number of fans. However, some places in my opinion has been successful in delivering real value to their customers like darband darake where exists this huge cluster of restaurants where you can have traditional foods in traditional way and i think it's interesting but of course again not for everyone

samaneh ghafurian 29, PHD in architecture, from Tehran

About your question, in my opinion, In Tehran we don’t have any successful public spaces which people can gather and enjoy their time, as we know what public spaces is?
But if you mean cafés and restaurants, I think that Saad Abad Castel and café Galeri in hessabi junction are good ones, because of their enclosed space and quite interesting buildings and specially their lighting at night and greenery.
In Tehran we don’t have such place like Plaza (Piazza) Novena, or other Piazza in Venice, therefore we don’t have any good example of public spaces.

Bahman ghajar 27, mastered in civil engineering, from Tehran

though I've the lesser architectural conceptual competence, but my idea indicates, Formerly called "Caledge 4-way"...why? as the ambient is a full-scale university and student oriented type. Café shops, book stores, public artistic places-such as City theatre, Ferdowsi Theater saloon and some exhibitions- are well connected, and function as a whole body. Actually I believe this is the reason why the majority of those who study in Tehran University, Politecnic University, Art University and Central Azad university of Art and architecture have a good experience of passing their university period. It seems that the complex of various ideologies gets human out of a solid and boring atmosphere...

Enghelab street and the area around it since old days has been a very busy district, all the students and cafes and book stores kept it full of livelihood. Most of the important enlighten society movements started in this district. I believe any type of learning environments, such as schools or educational centre would keep an urban area fresh and youthful.

mina farrokhi 27, mastered in production service design, from Tehran

Enghelab complex and Tochal. In my opinion The positive points of these two are (that are more or less the same in both but of course with differences):
1. They follow a main structure in sense of ambient and construction in the whole complex (Tochal is less like that though!!)
2. They are designed for a special reason
3.There are placed in the right locations more or less (compared to the chaos of Tehran that nothing is correctly placed!!) in sense of climate and traffic, etc.
4.Thanks to the big land space and better use of space (compared to other public places of Tehran) although it gets very crowded sometimes you can still find your own space
5.Good use of nature and green and controlling the cars and traffic inside
Ps. One of the main big problems of Tehran are the cars and traffic. So to me one of the most important condition for a successful public space to to handle this disaster!!

Tochal or baame tehran is an space before starting a trail to the mountains located north of tehran. This vast space has a terrace looking all the city of Tehran. With some food shops. There are some tennis court and a huge stage to have performances on national festive days and holidays. Time to time there are temporary stands or tents to hold an exhibition.

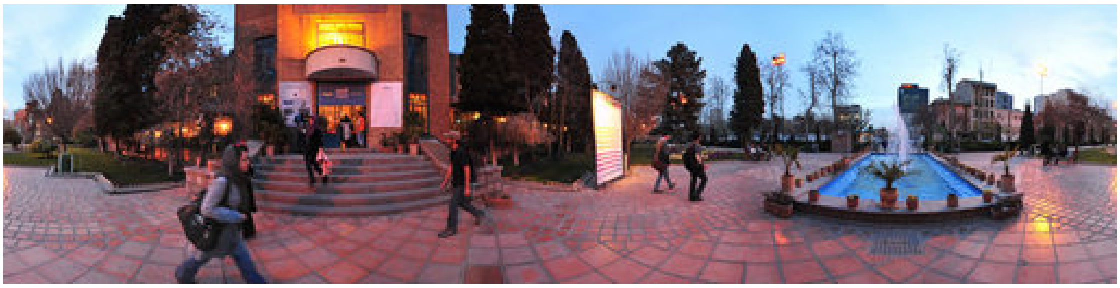
Leyla seyedi 39, chemist, from Tehran

I particularly like the grand “bazaar”. Its because it still has the spirit and the architectural of the old days. But yet there is a vibe and rush of society of current day. I don’t always go there to shop only sometimes I just go there to spend my day walking around, enjoying the atmosphere and have lunch.

The best thing about bazaar is its strong identity as an urban space, its one of the unique urban spaces that rules and guides the people's activities. Its very crowded yet very much in order. I myself like the religion effects. When its noon, you can hear azan where ever in bazaar, and bazaar starts to get empty, people go to pray. They all vozu in the yard of the main mosque where is in the center of bazaar. a social religious activity that people do together in the outdoor.

Sara afraz 23, mastered in architectural engineering, from Tehran

I like house of artists in Tehran, mostly because i can see a lot of different types of people over there. There are artists, students, families, musicians… i can catch a theatre or just look at artefacts in the cafe.



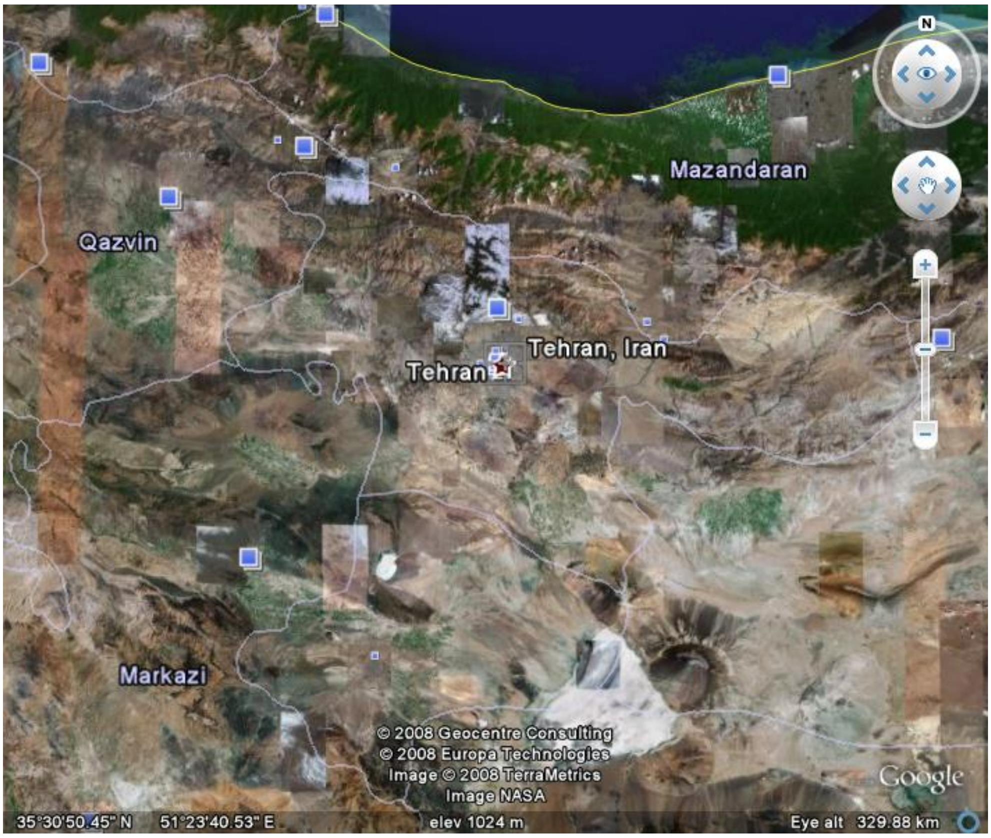
According to case studies and interviews, I would like the urban space that I am designing and introducing in this project represent these characteristics:

1. a highly communicated mix of outdoor and indoor spaces.
2. all the urban spaces should follow each other tangled in natural environment.
3. spaces function in direction of improving purpose of socializing.
4. diversity and flexibility in uses.

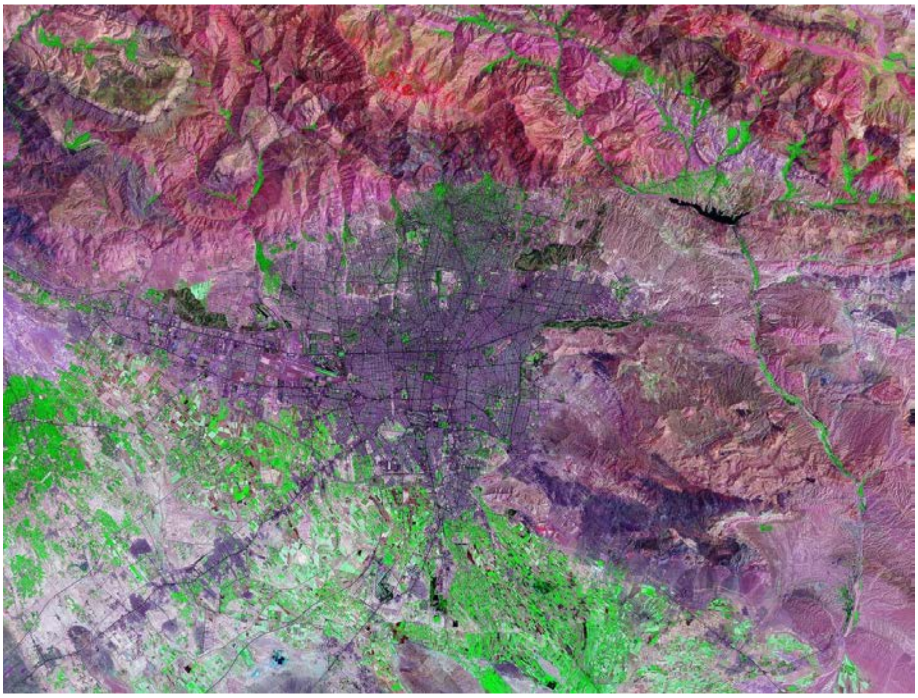
5. locate a complex of functions together so the travelling through city traffic would reduce yet keep harmony and continuity between spaces.
6. advertise and introduce a correct use of outdoor public spaces.
7. inject culture to urban texture.
8. an urban space where there are lots of diverse sitting area.
9. an urban space which had a opportunity to exercise and move around a bit in fresh air.
10. even outdoor green spaces in order to be useful need boundary to be defined and scaled.

Tehran

Tehran is the capital and largest city of Iran, Tehran is a sprawling city at the foot of the Alborz mountain range (the highest point in the Middle East (1,191 m, 3,900 ft. The population is approximately 15 millions.

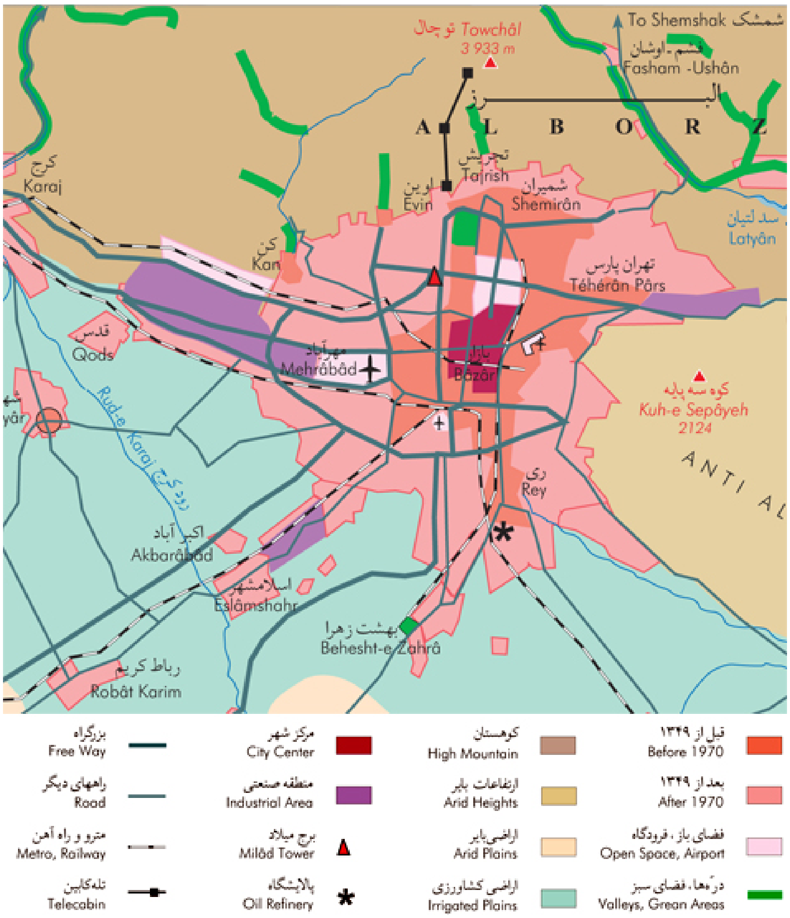


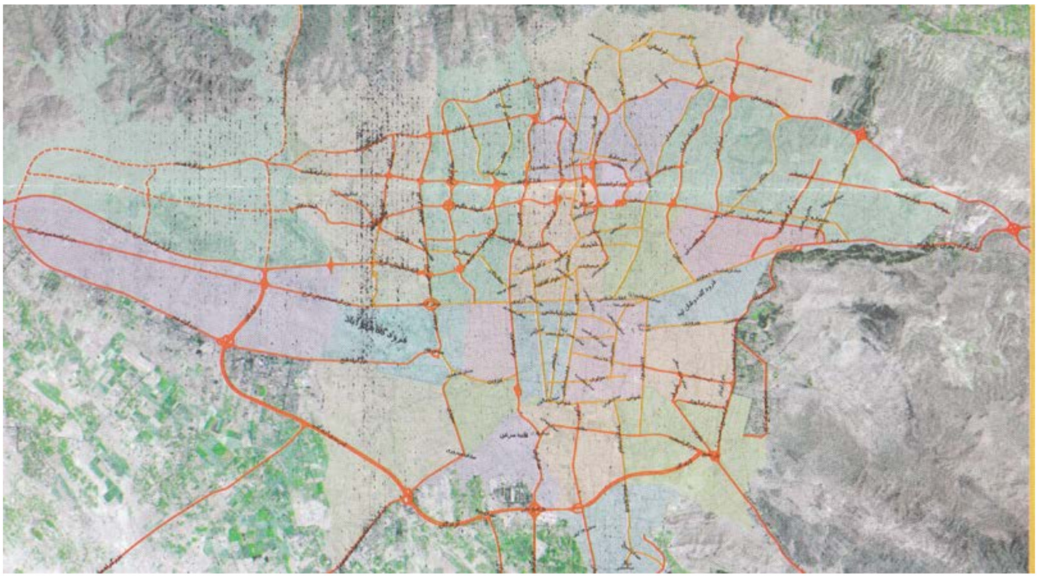
Tehran sprawl with respect to the mountains



The city distributions and green ratio

The roads map

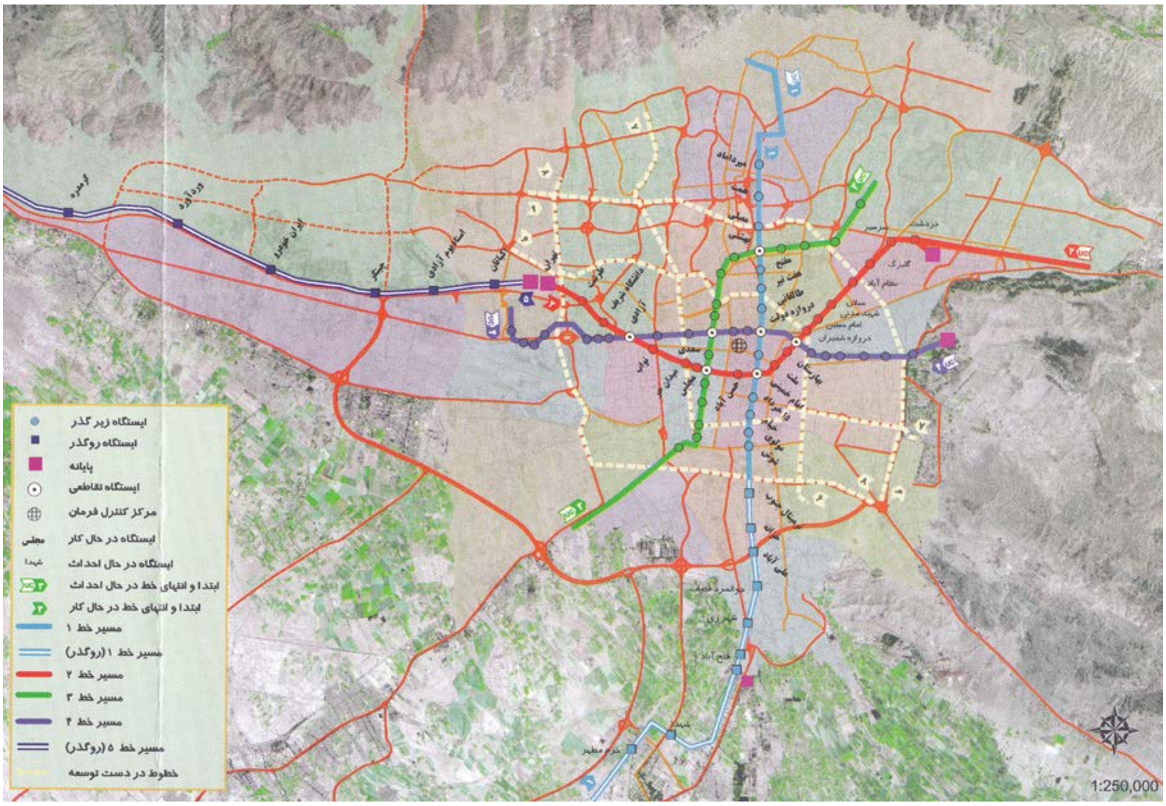




The red lines are the highways, the yellow ones are the main streets and the dash line is the high ways in the process of construction.

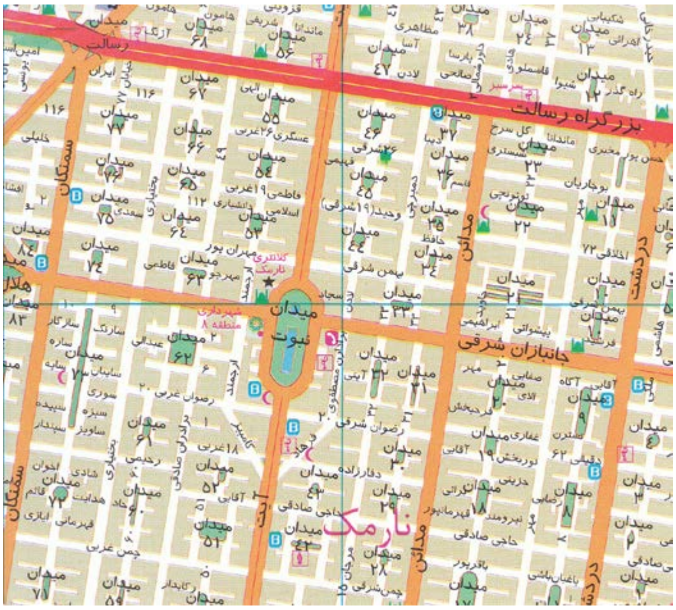
Transport system in the city:

In the next 5 years development will be:



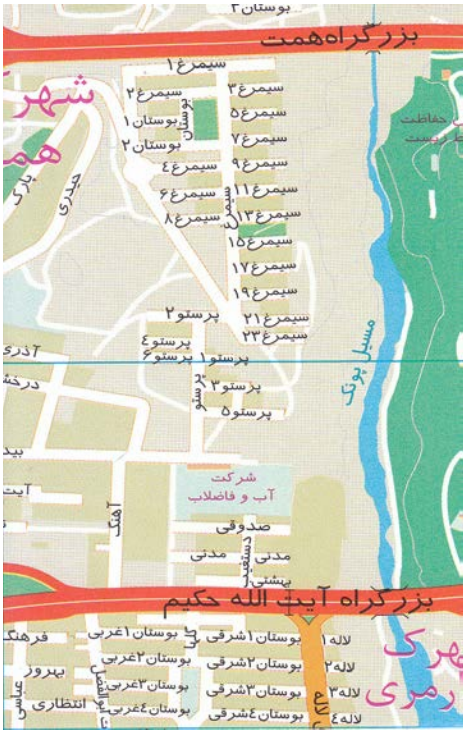
the other lines are in the process of construction.

Case studies of urban planning



Narmak is one of the old district of Tehran, located on the east central side of the city. its a good example of traditional but well patterned and distributed urban planning in Tehran. The area is mostly residential and patterned in a grid. Main streets meet and create a square in the plan which each contains 4 alleys and a round about of green area. Each round about has a number and that’s how they are being addressed. The shops and restaurants are located in the bigger streets shown in orange. The main huge elliptical round about in the centre of the area and is the domain of public area, with a mosque and municipality located around it,, is always crowded and alive.

Dezashib is an old district located north of Tehran on the foothills of alborz. There fore is a topographic area with steeped alleys and street. This area had a very random sprawl. Getting lost in this area is very common, since its full of dead end streets and narrow streets that do not follow any specific pattern. in the winter the accessibility gets even worse since the icy steeped streets makes it really hard to go around. The area is mostly residential and do not have a well defined public and commercial centre, there are some food markets now and then but the area gets very quiet at night generally.



Homa town could be considered as a new sprawl of the city, the environment is similar to the choosen city area of mine, with a small river and green protected area by it’s side. the pattern is very well distributed with green gardens every 5 blocks. The streets have number and going around is easy and well guided. With 2 important highways passing this area on the north and south, the accessibility to the area is well provided too.

These are two very important residential towns located on the west of Tehran.

On the left is ekbatan complex, (Persian: ناتابکا کرهش) is a planned town built as a project of modern apartment buildings in western part of Tehran, Iran. Today it is considered one of Tehran's neighborhoods. It is the largest residential complex in Tehran. The Construction of the Ekbatan complex started in 1975 for the purpose of mass housing. It has 15,500 units on an area of 2,208,570 m2 located in western Tehran.The designer of the complex is Jordan Gruzen (now Gruzen Samton LLP) from the United States.[1] Another American company by the name Starrett successfully built and completed phase I of the complex before hitting the revolution.[2] European contractors were also involved in the project.
Ekbatan has 3 separate sets of buildings called a phase and each phase has independent buildings categorised as a block. The architecture in the first and third phase are similar and are very different from the phase 2. Each block of phase 1 (or 3) has 3 major steps. When looked at from the sides, there are 5 floors in first step, 9 in second and 12 in the third one. In phase 2, blocks are designed like huge 12 story box-shaped parts that are put together in an angle. Another difference between phase 1(or 3) and 2 is about interior layout of the apartments. In phase 1 (or 3), apartments are single floored. However, in phase 2, they are built mostly in double floors (Duplex) with Hall, and the kitchen in the first floor and rooms placed in the upper(second) floor. In all of these phases you could find 1, 2, 3 or 4-roomed apartments that begins from about 50 m2 to 240 m2. Ekabatan complex is famous for its green fields between

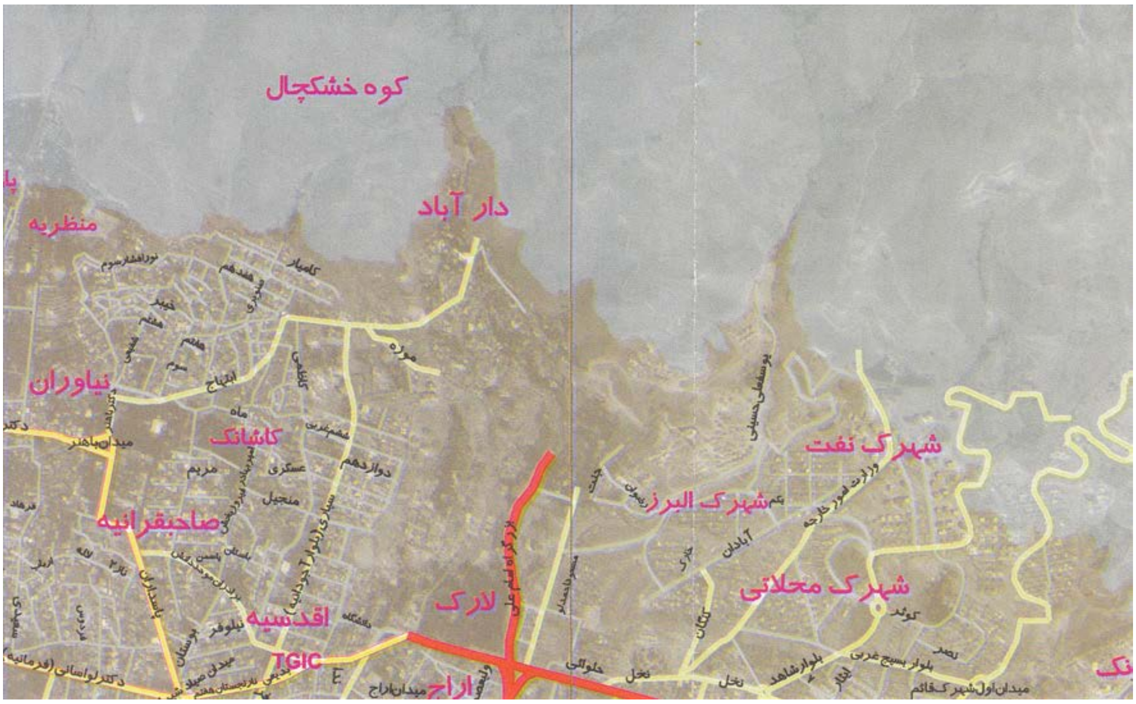
the buildings. The landscape is designed in a way to combine nature and modern living together, a concept that is being explored more in architectural practices today due to environmental concerns. Ekbatan is also full of different level schools in all three phases. Shopping places have developed throughout the last years and it is becoming one of the most convenient places for families to shop especially because of its competitive prices, higher qualities, and variety of goods and services. On the last Tuesday night of the Iranian year, before Nowruz, Ekbatan is the host of one of the biggest Chaharshanbe Suri celebrations in Tehran.

On the right there is (Persian: شهرک آپادانا) is a large residential complex in western part of Tehran, Iran. Today it is considered one of Tehran's neighborhoods. It is also the location of one of Tehran Monorail stations. Apadana Complex is located in the north-eastern side of Ekbatan Complex.The construction of the Apadana Complex started in 1970's. Some parts were finished before 1978. It was first residential in 1987.
There are 46 blocks in Apadana Complex. Each 7 or 8 blocks are categorized in one phase. There are 6 phases in Apadana Complex. Each phase has its own separate and independent administration.
The population of the Apadana Complex is about 15000. There are 3 shopping centers, 7 schools and a mosque in the Apadana Complex.

Project site and the area around:

The urban area 300 km by 400km around the project site is shown in this map which the scale is 1/16000. this area is a new development neighbouring Tehran on the north east side on the foothills of alborz. The fresh air on this area which is considered the region 1 out of 22 known regions of Tehran is very valuable. On the east side of the map there are alborz, naft, golha, langari residential complexes. Designed each in their own special grid due to the topographical reasons. The horse riding club, the medical institute of daneshvari, the museum of wild life of darabad, the noor hospital are the existing facilities in this area.

In the centre of the map there is an area of 30 by 50 km is assigned to trash hauling which is very important to this project, regarding buildings designed 60 percent by recycled wate and furniture.
And of course not to mention the area on the northern part of the site which is assigned to camping and hiking trails to alborz, Which I aim to keep as the aim of the urban project.



This is the map of streets in this region, the light yellow streets are the bystreets and the yellow ones are the main streets, the red one is the highway. And the grey ones show the alleys.

the site map:

Satellite view:

The first conceptual plan:

The concept is to create a treasure box. The residential complex is located nearest to the foot hill, and its actually on a higher level than the rest of the buildings. Right after the residential buildings there is the hiking trail.

The site is devided to two parts according to the green axis.

The hiking centre which is a building where there is a big store selling hiking and camping equipments, an office and information centre, where people can arrange for guided hiking tours and get information about the trail, and an eatery/café. Which sells appropriate healthy food to

carry with to hiking, the example of eatery is a chained one in UK names “eat”.
http://www.eat.co.uk/ this eatery also function as a meeting place for hikers.

The camp site already existed, only some developments are added, Such as some built accommodation, mostly bungalows. And as the urban municipality laws each quarter or residential mass needs to be provided by schools in the area. There fore the school building is located near the residential complex, enough close so that the students can walk to without necessary company.

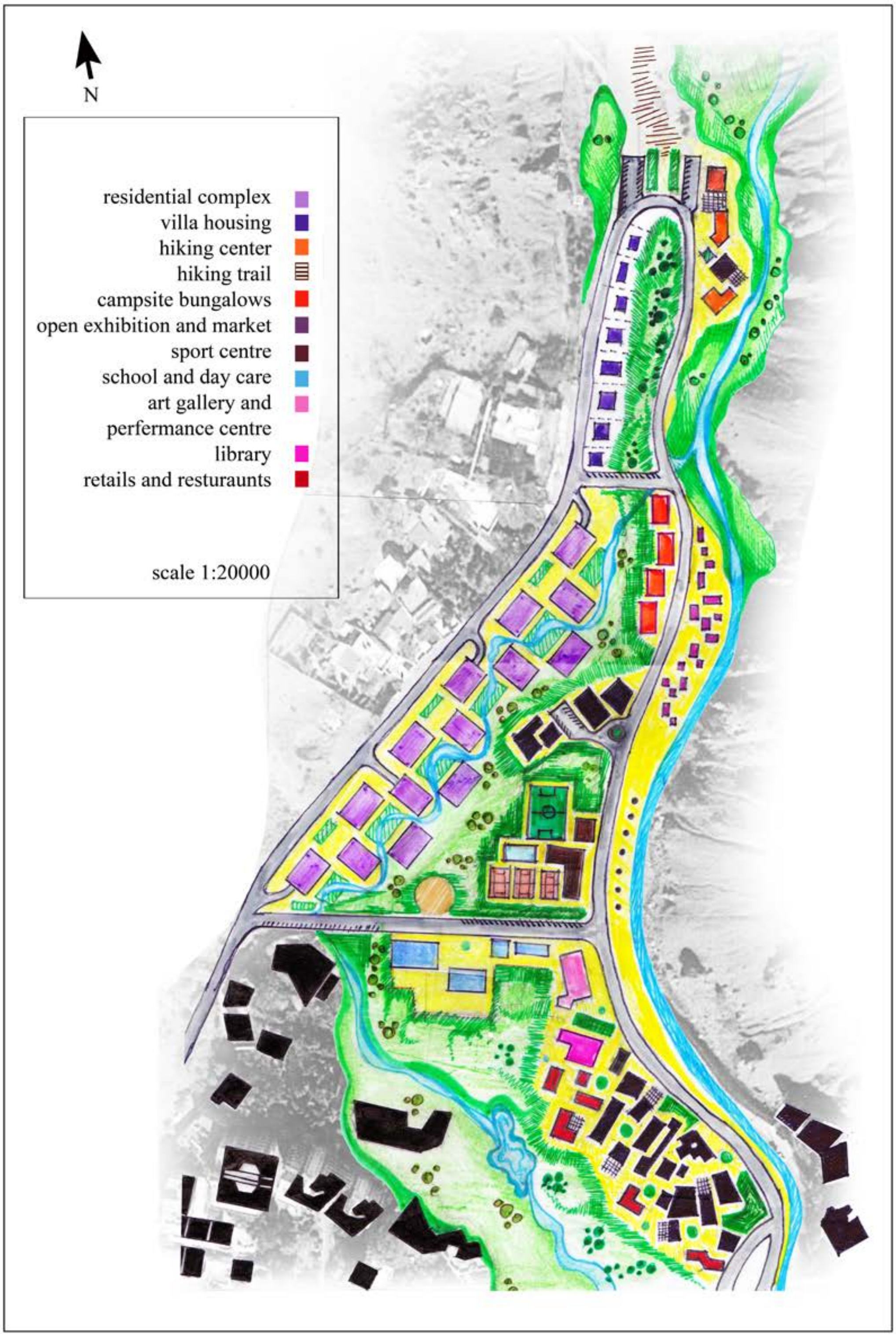
The semi open air exhibition space in front of the camp site, is actually a shaded designed area for markets, or temporary exhibition which reservations are available in the hiking centre office. This place is designed with the aim of socializing and make small hobby jobs for youth or housewives. A day market is always a place of interest in neighbourhoods. House wives can sell their home made bakes. Youth can sale their hand made crafts. Fund raising events can hold up here or Some street shows and performances in the weekends.

Blocks colour in black are the existing residential buildings.

The library and cultural centre are the two functions located close to each other probably even linked by a bridge crossing the street on the higher level. With having a hospital and a medical institute, a library is a proper function in this urban texture. And as one of my most important aims in this project is to help bring back some culture and identity back to the busy people in the city, the cultural centre which can hold performances for any age categories and any category of art, such as theatre or folk music performances, could be a dominant point of this neighbourhood.

According to the urban planning new law of municipality, every urban neighbourhood should be provided by sportive centres. This area has been equipped with some street exercise instalments, and it ends already to a natural reserved hiking trail. To have an sport centre, which hosts grounds for tennis and football, it could serve to the whole area of darabad, in sense of a sport centre.

The urban plan:


N
residential complex
villa housing
hiking center
hiking trail
campsite bungalows
open exhibition and market
sport centre
school and day care
art gallery and
perfermance centre
library
retails and resturaunts
scale 1:20000

Introduction to Iranian architecture

the oldest architecture in Iran was born by hakhamaneshi period. It goes back 2500 years back. The so called architectural style named parsi style. The columns were very dominant also the broad arched vaults. neighbouring with Greeks brought new mix of culture and meanings to the architecture later, such as porches, domes and the courtyards surrounded by columns. These roots in architecture still can be found in the architecture of Iran these days.

Although Iranian architecture is nearly more than 6000 years old, but amazingly most of architects and researchers believe it has always kept 5 specific characteristic:

1. contains humanistic aspects
2. functional in means of design, planning and construction
3. using the native building material
4. proportional and scaled
5. focused on the quality of interior spaces

A journey to an Iranian home:

Plan

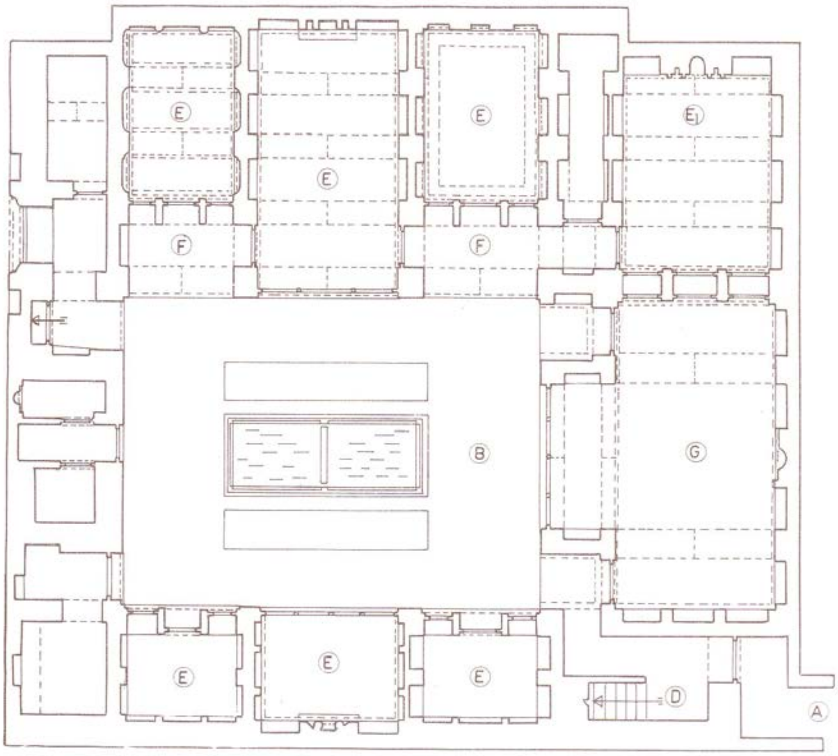
An entrance in a traditional Iranian house plan is hardly noticeable from the outside! The outer look of Iranian houses is plain, which gives a good feeling of relaxed and secured residence. a home is the main axis of the union of the family. So it always was design in a way to be separate from the outside world and in it's construction the focus was on the values of the family. In such a society the house is more than a private living space, but it's a sacred shrine there fore it should be protected. There fore the yard of the houses has been very central and surrounded and private. The courtyard brings light and air to the house and in every means it's the most important part of the house.
The outer side of an Iranian house is surrounded by tall plain walls and there is no communication towards inside unless the main entrance.
As iran became an Islamic country shortly after Islam came to Saudi Arabia around 600 a.d , Islam was really effective on the development of architecture in iran. In a traditional house its clear that the spaces are divided to two mains: "private" which only were uses by women of the house and semi-private which were used for the guests and men of the house. In these places women had to wear veil. The entrance is small because of the privacy issue again. And usually lead by a narrow corridor passing through a "hashti" to the courtyard.
A hashti is a small room usually placed right after the entrance, It could be in the shape of octagon or half octagon, but most of the times its just a square plan. It has a small aperture on top of its dome for light. Since it's the first space that people would enter as they come in to the house, its very important and the size of it represent the financial position of the family. the walls which are made of a mixture of clay and straws were normally kept wet in summer there fore it was the coolest room of the house. This way the incomers from outside arrived just from under the burning sun would welcomed by a conditioned air in the hashti.
Its amazing that almost in every Iranian house an entrance leads to the courtyard, Before any other space in the house. More or less courtyard was the centre of all the activities of the household as on the other hand was a main connectivity space between all different parts of the house. As the plans are shown all the courtyards contain a small pool where the household used to wash the dishes, fruits, vegetables in it. even sometimes it was used as a natural refrigerator! Leaving a watermelon

in the cool water is still a tradition that Iranians sometimes follow. The water of this pool was used to water the plants and even wash the courtyard. The pool itself aside from its role as a decorative element helped in the conditioning the air and environment of the courtyard, cooled it down and humidify it.
“Hayat” meaning courtyard Is a word in Farsi that is called to a place surrounded by walls. It has various roles and functions such as :

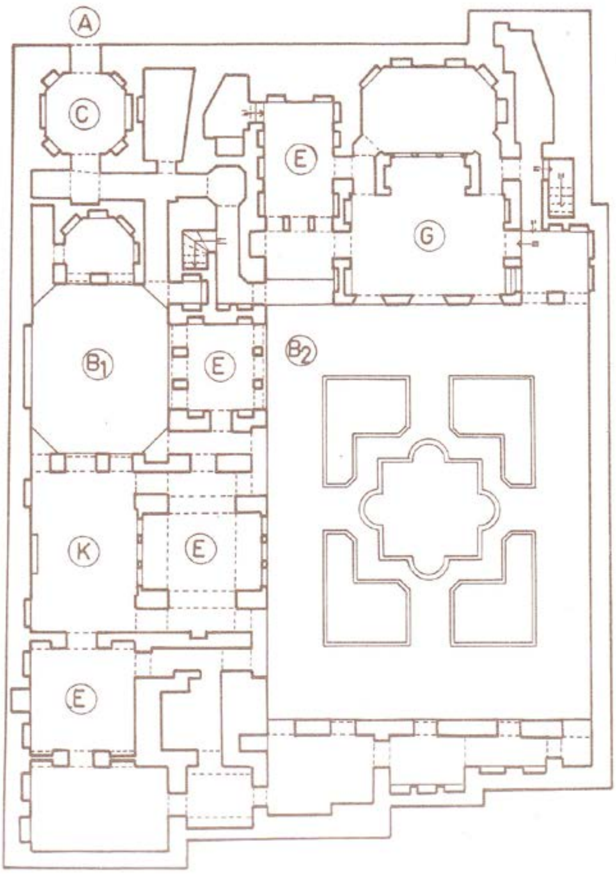
1. sign of property
2. keep relationship between different spaces
3. bring in harmony between all different functions in the house
4. green space
5. air channel
6. the most important space in organization and design
7. a secure and calm space for the residents to rest and have fun

All the rooms were built around the courtyard. The biggest one was the hall. This usually had a wide porch in front. The porch came from the concept of a tent, the parti architects always kept their roots in living in tents. The old houses could have even up to four porches on four sides. the porch or portico as well as being a transition space was also a very useful space. a guest might have been hosted in this space instead of the big hall when the weather was suitable. The family members would gather around in this space have tea, or fruits or even each do a business of their own while all hanging out in the portico or so called “ eivan”.
Like the tent, the porch also leads to a big entrance, the main big room or so called hall. Where the guests were hosted by the household, food was served for all on the ground as an important tradition, gatherings were held… It was decorated finely and with fine layers of Persian carpet on the ground and large cushions to lean on to have all the guests seated in a round manner to chat and communicate. Sometimes There used to be two main halls in every house, one in the summer side and one in the winter side, located on the two opposite sides of the courtyard. If the house wasn’t big enough to have both summer and winter sections then the designer would plan spaces around the courtyard according to their function dependence to the environmental factors. Normally the places where get the most sun in winter stay in the shade in summers. There is less crowded construction on the sides where gets more disturbing sun, such as west.
And that as far as a normal guest would go in an Iranian house. The rest were mostly private and only for the household to use. but isn’t it amazing the sequence of entrance in these houses? First entering a closed conditioned air space to freshen up, then in to the most beautiful and active core of the house which is an open space, and then to a semi-closed or closed (porch in the outside or hall inside) to be hosted with tea and fresh fruits, depending on the weather condition or time and aim of the gathering. Its an harmonious sequence with the natural environment and functionalism and a hospitable culture.
The basement is also one of the unique spaces of an Iranian house, its supposed to be cooler than the rest of the house. The storage for food, the bathroom and the toilettes are located in the basement, in order to keep the smell and vapour away from the rest of the residence.

A. entrance
B. courtyard
G. main hall
E. rooms



Ground Floor Plan نقشه همکف



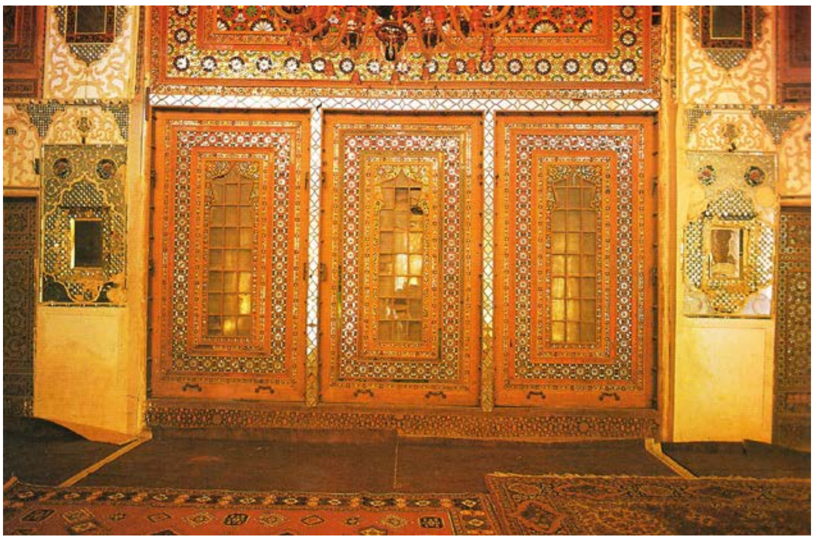
A. entrance
C. hashti

B2. entrance courtyard
B1. private courtyard

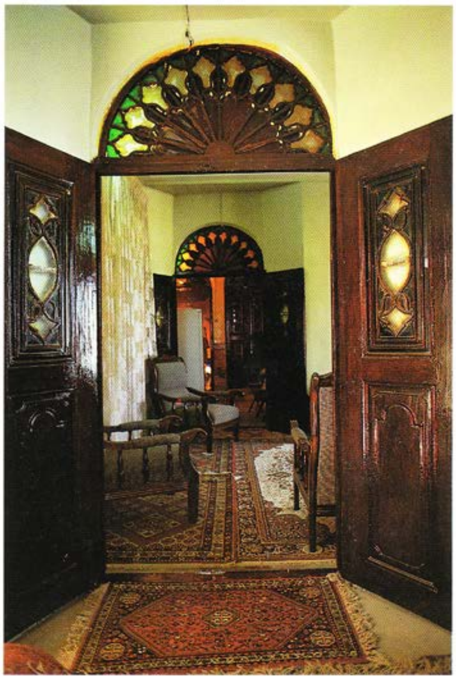
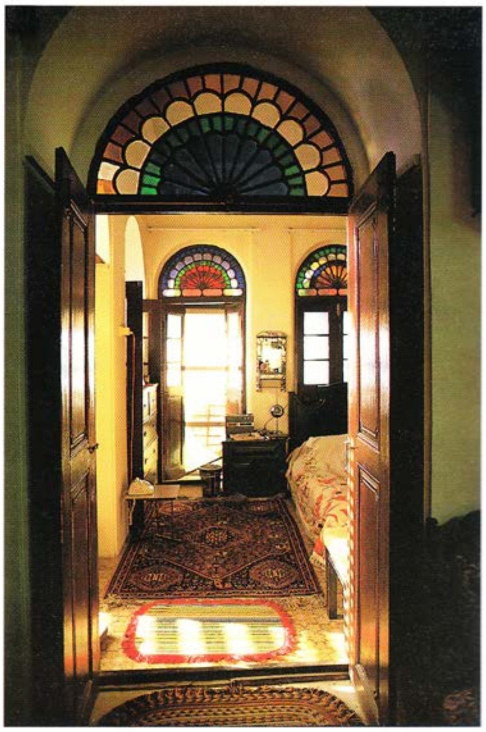
E. rooms
G. main hall

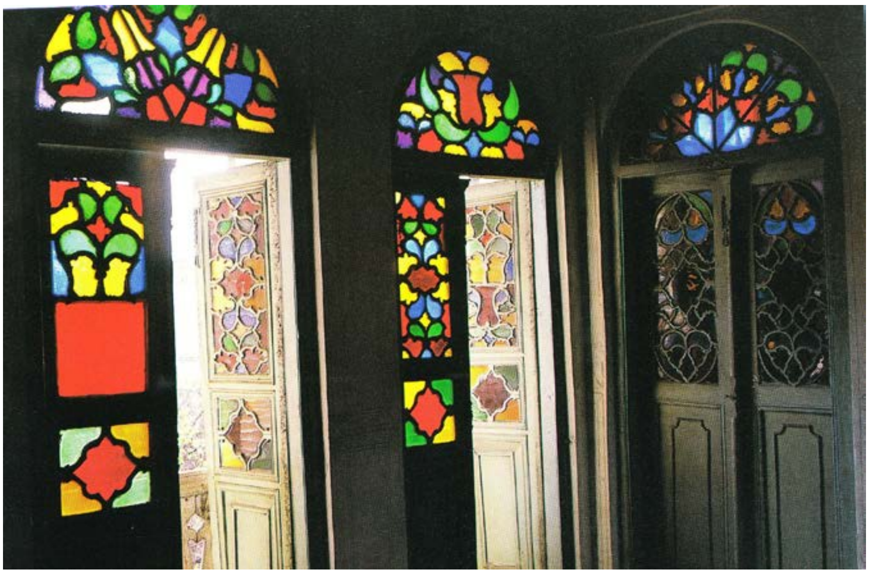
Interior

All the rooms in an Iranian house is covered with carpets on the floor. Carpet is thick and heavy cloth. At first it might looks like just a decoration or in today's world a luxury. But covering the whole floor with such a thick cloth is a clever insulation at the same time. In summer or winter helps moderate the temperature of what we walk on or in our culture case traditionally sit on.
Doors and windows of the traditional architecture in iran are themselves an art, full of stories. But what is interesting related to the energy saving topic is that mostly windows are so carefully and beautifully made out of 100 pieces of coloured glasses, Which gives an amazing effect to the inside space and at the same time function as a sun ray moderator element. In addition to that from out side another layer was added to the window which usually is made out of wood with detailed carved small openings. All of these together work as a sun shading complex which can be controlled through the year according to the desire of the user and amount of the sun.
This got my attention since in the present residents in Tehran most of the buildings have been built such close to each other. The privacy issue which has a deep root in our culture and religion became such a dilemma. People use heavy two layered curtains which block the whole sunlight and block the relation between indoor space and outdoor space totally. this can be replaces by the traditional old method, A colour window combined with some percentage of mirror effect on the outside can provide enough privacy While it keep a great effect inside. Changing of the shades and colours intensity during the day would keep the residents conscious of what time of the day is, And in general would always keep a sense of outside inside. The outer wooden layer carved in harmony with the design of the window can be tilted as is desired manually according to the amount of sun. the point is while the windows are open these shading boards other than the role of shading still can satisfy the need of the privacy at some level.
By a second look at the interior, setting aside all the infinitive paintings and decorations, use of mirror really stands out. The rooms with mirror decorations are brighter and seem bigger. In a big space with all the shadings blocking a great amount of sun pouring in, sometimes light is missed a bit. Placing all these small pieces of mirror in a decorative artistic way all around the room covering walls helps the small amount of light which comes in scatter with a balance in the whole space not to miss even an angel.
the decorations in Iranian architecture is not only to make a sense of beauty but it has a spiritual effect, at some point holding a meta physic concept. They aim to mix the materialistic spaces with spiritual values. That's why they don't belong to a special time or place. As the ziggurats were the bridges between the earth and the sky, so were the mosques and the houses. A house is a symbol of sky on earth and the courtyard is the centre of it.



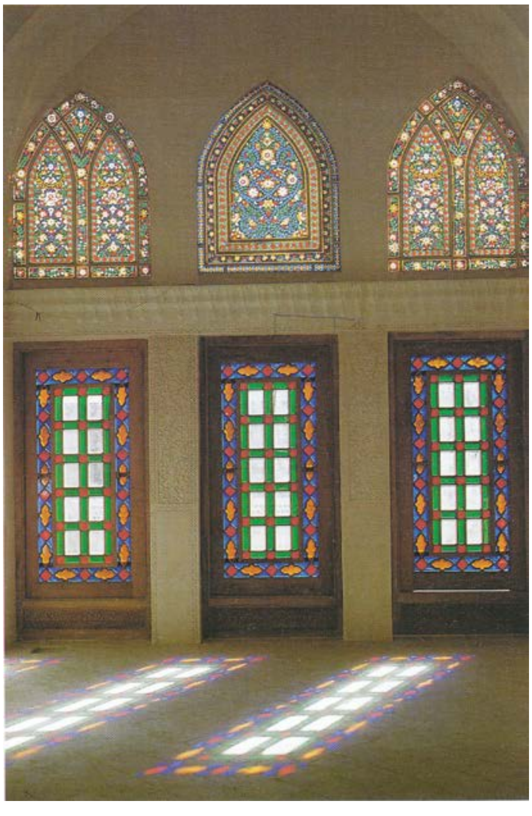
mix of wood, mirror and carpet

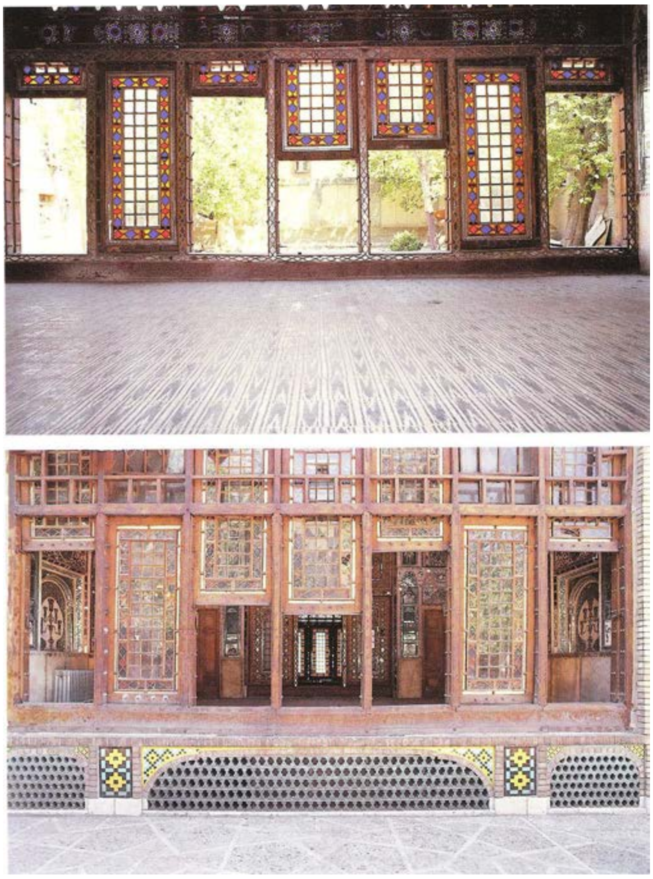


The use of colourful glass

Mirror craft on the walls help diffuse the light



The light effect on the interior space using orosi colour widows



Wooden sun shading carved outer layer of the orosi windows

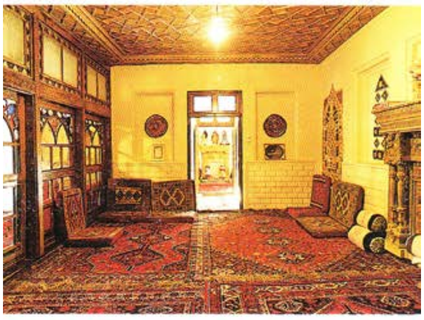
Hollow brick sun shadings

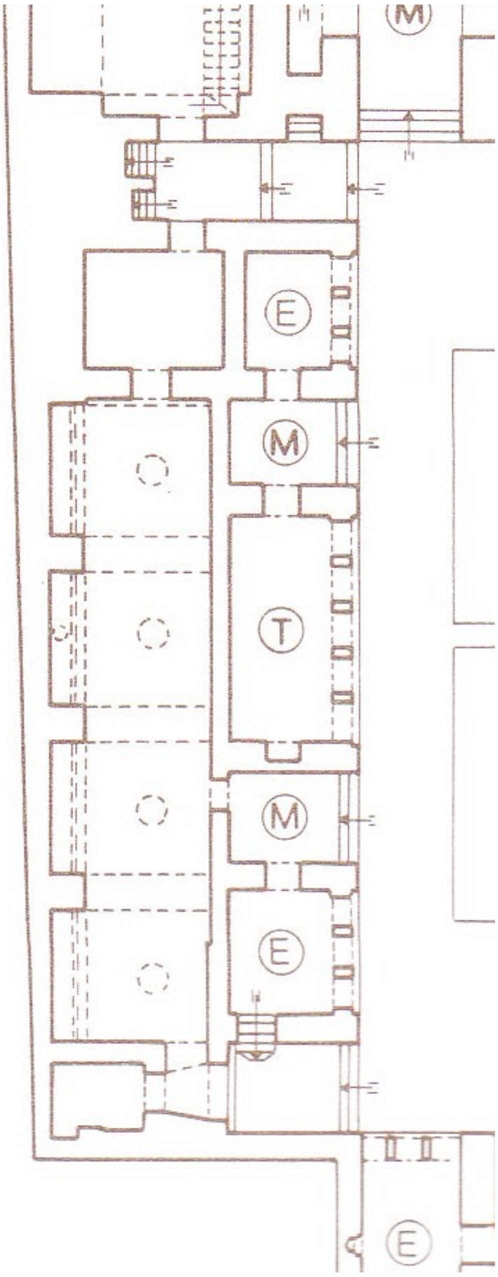
The proportions and modules:

The architect would first take the dimensions of the land and then ask for the client requirements for the number of rooms and their size. So the first important number was the number of the family members.

The bed rooms usually had 3 doors out and the bigger rooms to hold the guests had 5 doors.

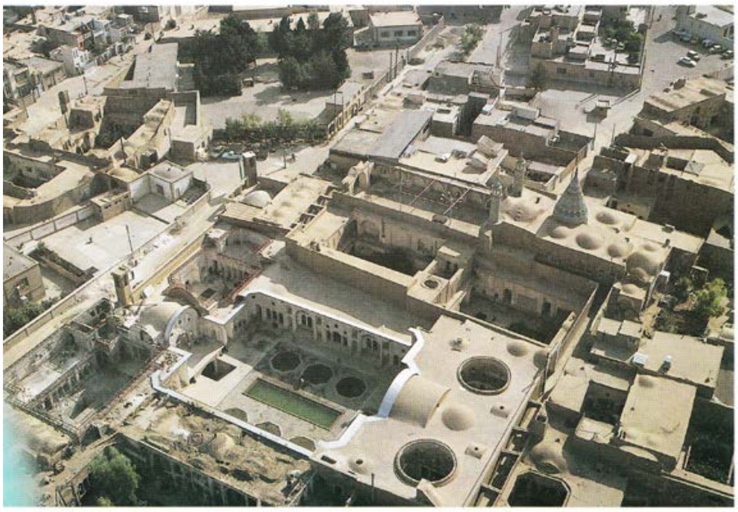
Usually the floors of all the rooms were covered completely with carpets, so the size of the rooms was according to the sizes of the carpets, some how the sizes of the carpets were a size modulus for spaces.



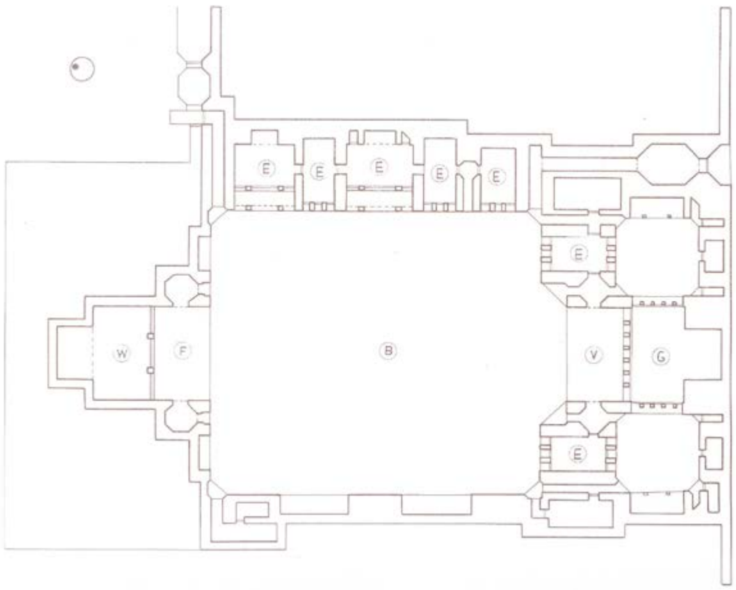


The role of natural energy sources:

Iran is a country with a wide range of different climates from north to south. Where we are speaking of in this thesis particularly is Tehran the capital. This has all four seasons around the year in their full appearance. A very hot summer, a snowy winter, spring with all its blossoms and shower rains and autumn with a yellowish look followed by heavy wind and rain. This environment surely needed a lot of energy to live in! and what people weren't familiar to fortunately at that time was the heater! Or coolers! So many answers to sustainable architecture of today is actually right at our past, if we turn our heads!
In the plans of these old houses there are marks for two kind of spaces; winter spaces, and summer spaces. Summer rooms usually have their openings towards north and they are followed by a transition space of roofed porticos outside. While winter rooms have their openings towards south or south east/west. With a wide totally open portico outside of them in bright colours which helped with having some extra reflection in add to the sunrays itself. Well of course they had a lot of space back then, but still it's possible to have two sets of openings for summer and winter for one space in contemporary architecture.



The main façade of an Iranian house is through the courtyard. There fore the axis of the courtyard is designed according the sun path.



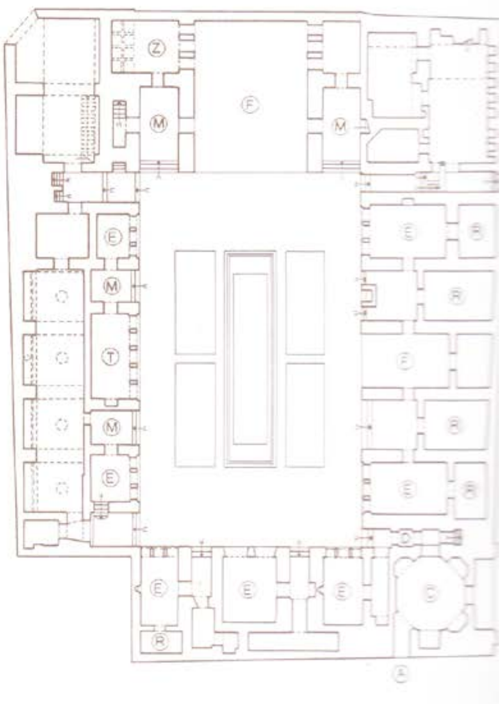
W. winter hall

V. summer roofed portico

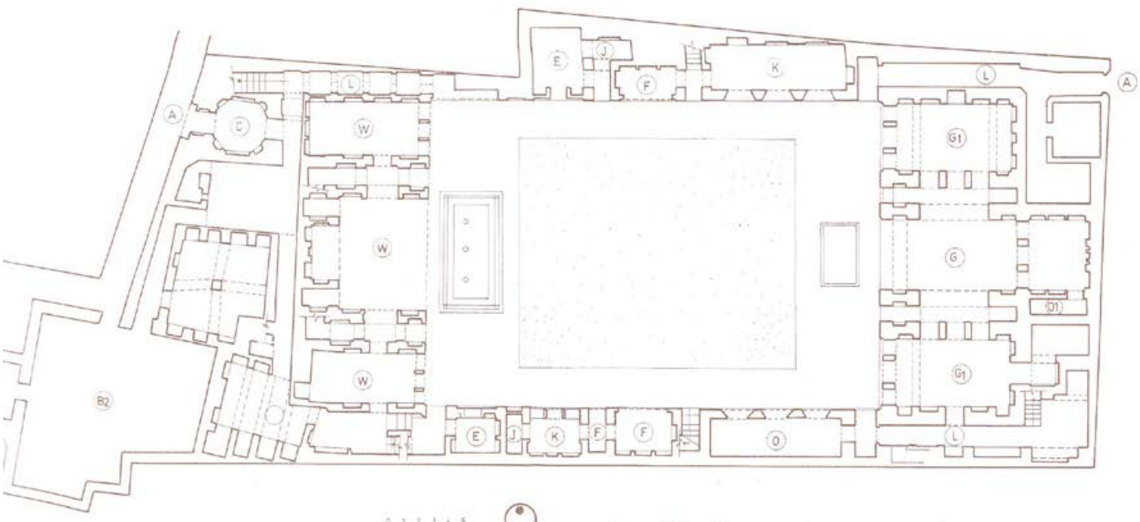
F. open portico

G. summer hall with a lot of small openings

Planning a courtyard in the centre of the rooms with a pool in the middle and greenery, plants, trees all around it right in front of doors and windows of the rooms is a great air conditioned design. The air which has been moderated by the pool and plants would breeze through the rooms passing by the shade of trees on the windows.

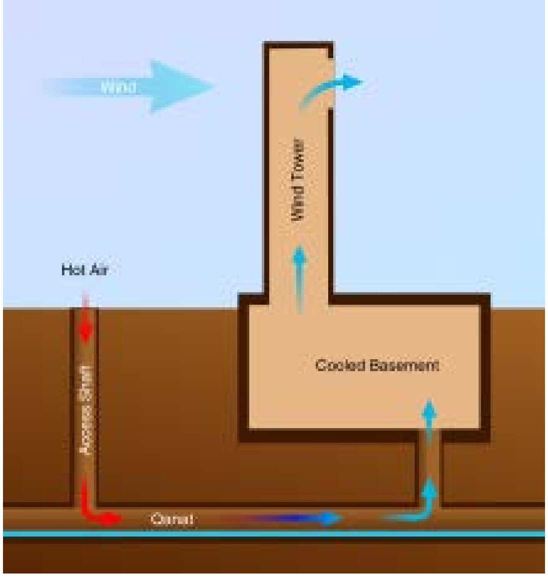


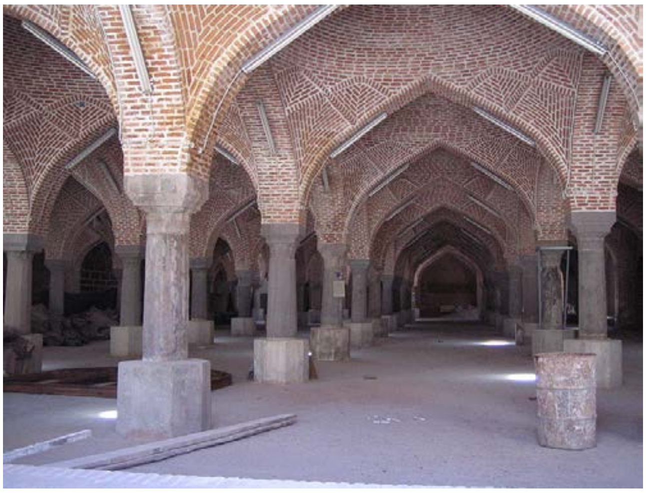
Use of the water in the courtyards helped with the conditioning the air and humidify it.



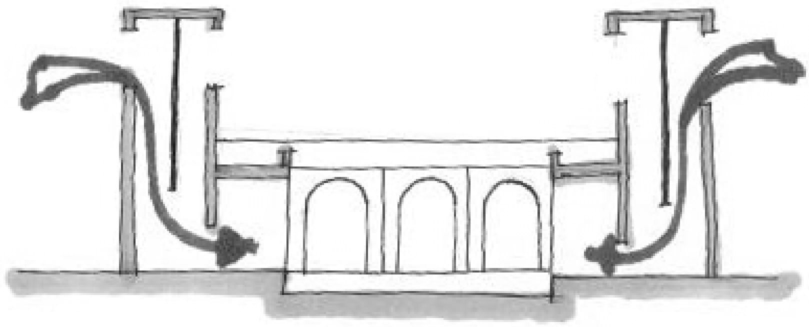
Ground Floor Plan نقشه همکف

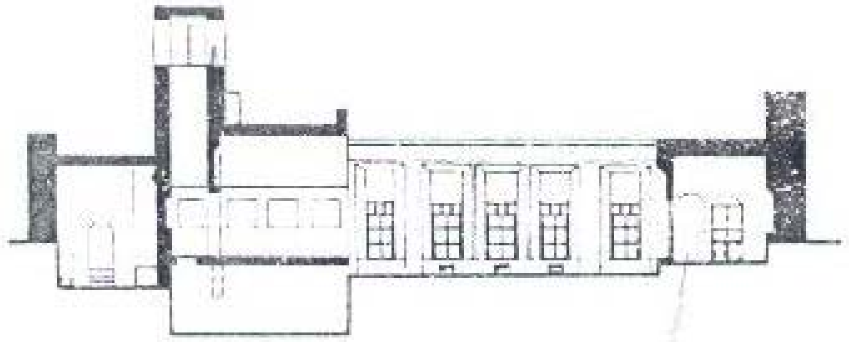
A Shabestan is an underground space that can be usually found in traditional architecture of mosques, houses, and schools in iran.
A shabestan can be cooled using a Qanat in conjunction with a wind tower. A wind tower is a chimney-like structure positioned above the house; the one of its four openings opposite the wind direction is opened to move air out of the house. Incoming air is pulled from a qanat below the house. The air flow across the vertical shaft opening creates a lower pressure (see Bernoulli effect) and pulls cool air up from the qanat tunnel below the house. The air from the qanat was drawn into the tunnel at some distance away and is cooled both by contact with the cool tunnel walls/water and by the giving up latent heat of evaporation as water evaporates into the air stream. In dry desert climates this can result in a greater than 15°C reduction in the air temperature coming from the qanat. Wind tower and qanat cooling have been used in desert climates for over 1000 years.





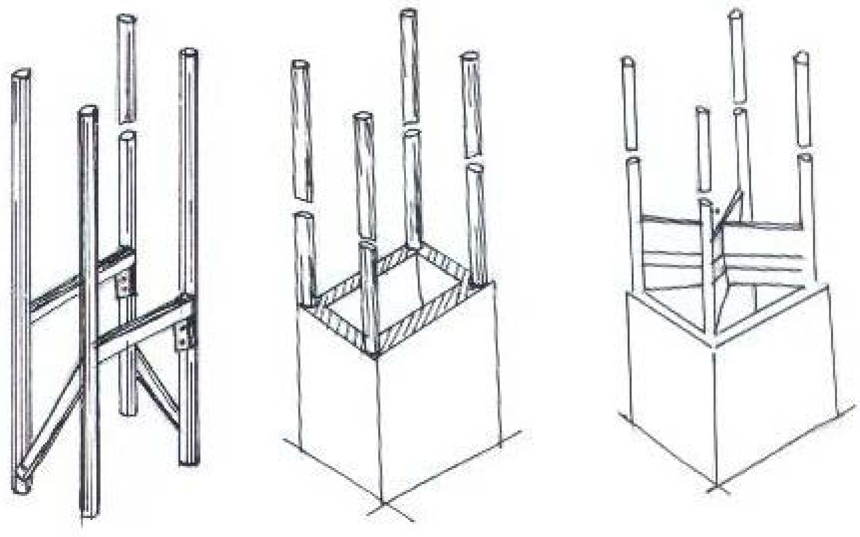
Wind tower is a key element in traditional architecture of Iran. It is seen in settlements in hot, hot-dry and hot-humid climates. They look like big chimneys in the sky line of ancient cities of Iran. They are vertical shafts with vents on top to lead desired wind to the interior spaces and provide thermal comfort. In traditional architecture of Iran, climate, local materials and renewable energy resources have been used.
Wind tower shows the harmony of human built environment with nature. Traditional building techniques were normally well adapted to the climate. However, the modern way of life and western technologies have often replaced the established traditions in the design of the buildings. Wind tower is divided into several vertical air passages by internal partitions or shafts. The shafts on top terminate in to opening on the sides of the tower head. The flow in side the wind tower is in two directions, up and down. Namely, when the wind blows from one direction the windward opening will be the inlets and the leeward opening will be the outlet and vice versa. There are one-directional wind towers, they are facing to the desired wind and in some cases one directional wind towers act as air suctioning and the air flow turned its back to the wind to locate itself in a negative pressure region to cause warm air in interior to blow out of the hou





A section of an old house in yazd in iran.

Body of wind towers soar to receive winds in the height. Open vents reduce resistance in front of horizontal forces there for it is clear importance of structural elements. Mud brick and timbers are used in the construction of wind towers. Since a wind tower rises above a building, it needs elements to support it.



Architecture of today and its distortions

in a modern apartment in Tehran today you will find a kind of disturbed architecture caused by social effects. the bigger the apartment is the better show off for the residents would to present. And show off became necessary these days. But it doesn’t end here. Most of the space of an apartment would design as common space so it could be decorated in an expensive way to share it with guests or any comers. That means a big percentage of the space would be semi private and a very small percentage would be private. For example most of the 2 bedroom apartments are around 120-150 which is a quite big square meter. Only near 20% of this square meter would be private and that includes only the bedrooms. The rest would be a huge living room, dining room, kitchen to serve as a common area and hosting area to guests and hold parties, with not much of a proper definition of space. With a look through the society of Tehran and its governmental contrasts that seems about right. There is no decent public space to hold events or gatherings of any kind other that restaurants, Set aside limitations of appearance in the public. There fore if any one wants to have a gathering which in any way is in contrary with public laws they have to hold it in their own private space or residents actually. By considering these issues in every home it's very important to have a proper common hosting area. But the problem is the bedrooms which are remotely important! when the guests are gone they are not that pleasant. They are usually very small around 12 msq or even 9 with not enough light.

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Design scenario:

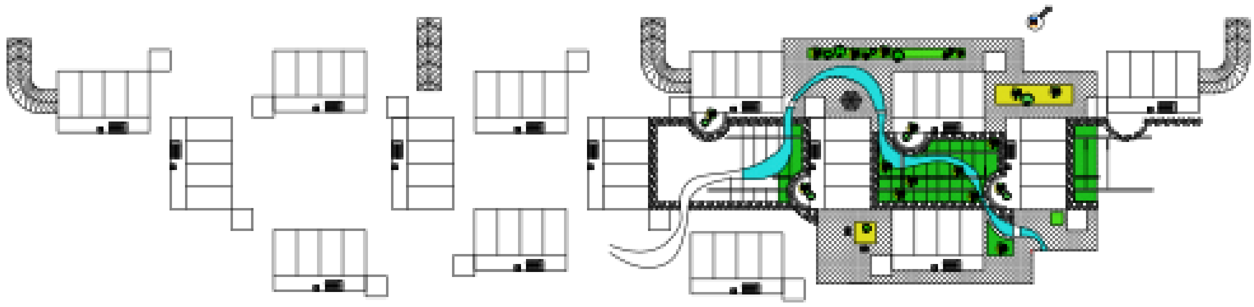
As architects we are supposed to design spaces according to requirements of the users. Living spaces are one of the most important spaces that people spend most of their life in.
This is the century of identity and self knowledge. These days we are very conscious of our differences as human beings. one of the reasons of success of face book is that because people have been given a basic electronic space where they have been given the chance to built it at their desire, change it every day according to their mood, and some how reflect themselves in it. The main characteristic of this popularity is that people have been given the choice of designing it by themselves at some level. a living space is a very private area, which reflects a lot about its owner. About their religion and culture, their habits and values… a proposal to make design less expensive and more personal is to design a space more flexible in order to form according to any user's choices, needs and characteristics. We can never see the world as in another's persons life, so its difficult and quite waste of time and design to make all the choices as an architect, like what is useful and what is aesthetic to the users. Which are the main bases of architecting a space.
Instead of focusing on what could be perfect space isn't it better to let the residents have the chance to define it themselves at some level? As an architect instead of putting all the effort on defining a space in its best way it could be a way of design to define a basic where a user can draw easily his own lines. In another word design an architectural guidebook for people to find ways to express their needs, desires and expectations in a space. A good living space is first of all an affordable one, some where people can feel their owner ship some thing valuable and long lasting. A space doesn't need to be complicated in means of design to be valuable and beautiful. But the beauty of architecture is to be the simplest and the most comfortable. This residential complex is minimal space for basic requirements of a living space rooting in proportions and values of traditional and cultural architecture. Where people have the chance to influence and characterise their own living space. in the traditional architecture in an Iranian house there were 2 kinds of rooms. The space of a room would be measured by the count of its doors. They had rooms with 5 doors and rooms with 3 doors. The 5 doored room was consider as living room and where to host guests and the 3 doors room were used as a private room. It means 40 % private and 60% semiprivate.

Plans:

The main concept of this residential complex is the flexibility.

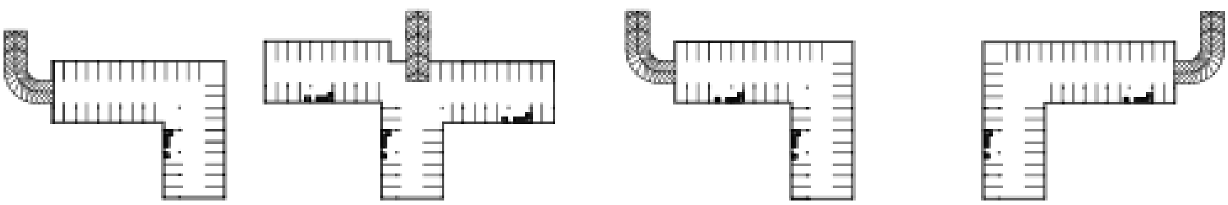
Flexible through time: The architectural culture in Tehran these days prefer new buildings. Maximum of good life of a building is 10 years. In every alley and street in Tehran there is a construction going on. The old houses and apartments being demolished and the new ones are being built. But in order to save energy and material in this project, the structure is totally independent from the built environment, there fore the structure can be kept and the whole building can be replaced.

Flexible In size and price: each block consist four rectangular lots, each 6 meter by 12 meter. The idea is to sell the empty lots, which is cheaper than the land. And then buy the built space to be installed in the lots. This way a couple might buy 2 lots and one built unit. This way they can keep their second lot for the future when they have kids and more money. Until then the empty lot will be kept as a courtyard, a green space, a garden or any other use the owners would choose.

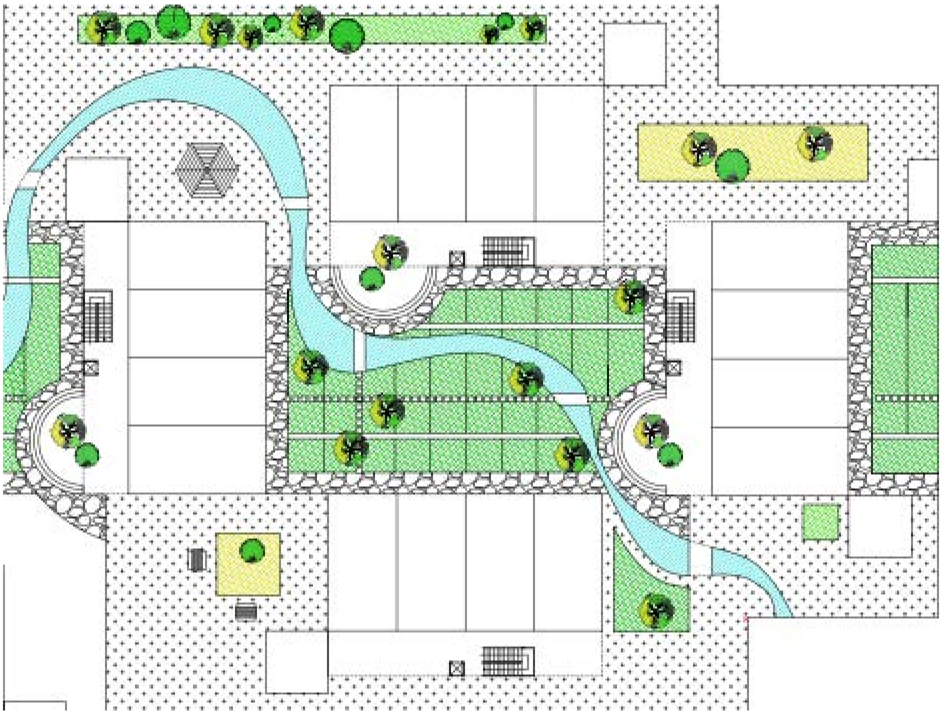


Blocks locations, their wind towers and the main central courtyard Scale 1:500

The main arrangement of the buildings has been done according to the direction of the north and south in order to get the suitable sun.

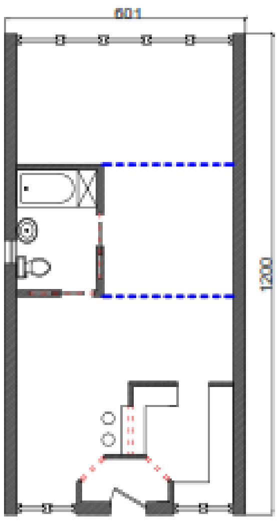


The parking are located in the basement, also if there is any need to have storage or heating instalment they have more than enough space for just only parking. Still if not the extra parking spaces could be used for guests.

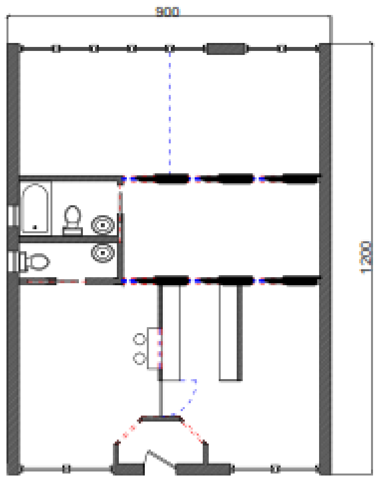


The courtyards are divided to small green gardens, every unit can have pieces and plant their own vegetations. This promotes a cooperative spirit of taking care of our living environment. And also give the chance to users to have possibility of embark some of the magic of simple life of the country side. the gardens which not belong to any one is being taken care of by the management of the whole residential complex.

Flexible to users: one precast unit is 6x12 m. which is a 72 sqm space similar to a loft With different choices of removable walls. also With definite spaces of kitchen and bathroom.

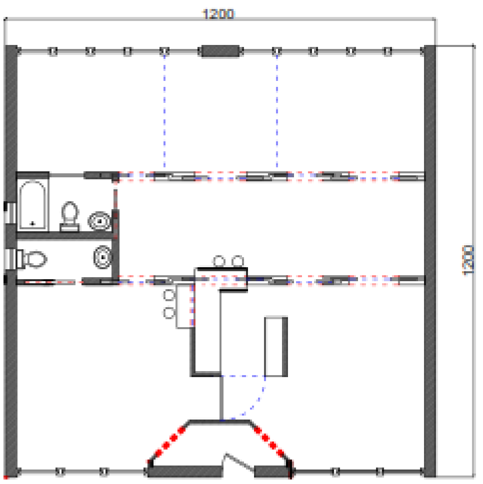


Scale 1:100
Blue dash lines show the probable placement of the walls. It represents the architect choice.



Scale 1:100 12m x 9 m = 108 msq 1.5 living unit, two bedroom

The sliding walls have the option of combining the spaces together, still when they are closed they transmit light yet block the view. Since they are curved orosi glass doors, they are sound proof as well.

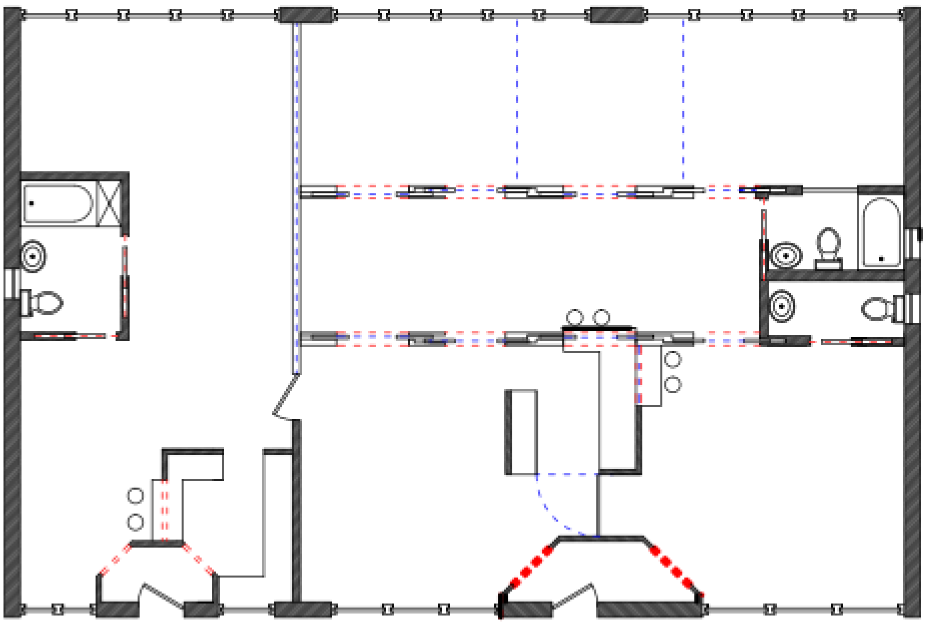


Scale 1:100 12m x 12m = 144 msq 2 living units, 3 bedrooms

The partition walls between the bedrooms are movable in order to change the size of the bedrooms according to the function and need at all times.
Again the spaces are linked with sliding walls.

In all the plans the proportions of the spaces are coming from the traditional modules. The ratio of the semi private spaces of the living space to the private space which are considered the bedrooms are 5 to 3. Like the 5 door rooms and the 3 door ones.
The space in between which is a transition space between the semiprivate and private space is actually a very personalized space. This a space that the residents decide about its use and function according their own way of living. Some might have it as a family room, some as a tv room. One

might have it as a study room or a music room… this is a room representing flexibility in means of function or meaning of a living space for a user.
The entrance is in shape of a half octagon. Like old days hashties. The octagon is a very welcoming shape resembling a hug. At the same time its not so much of a circle but a rigid shape with angles. Which represent the importance of the family and resemblance the restrict principles of a family in the society.
From the entrance the whole living space split in half. With the kitchen as the centre, some how playing the role of courtyard of an old Iranian house.
The woman in an Iranian house spends most of her time in the kitchen. The hospitality of a family roots in how they cook for their guests. A man comes home to have a delicious dinner in the warmth of the family union. The children are nourished around this space. as a matter of fact I have a lot of memories from my childhood following around my mom in the kitchen. In an apartment in iran today a kitchen is located in the centre accessing all the other spaces almost directly except the bedrooms.
One entrance opens towards the living room where the guests are welcomed and hosted. The other goes straight to the kitchen and access more private spaces of the house. These two parts can be totally separated from each other with all the sliding and movable partitions.

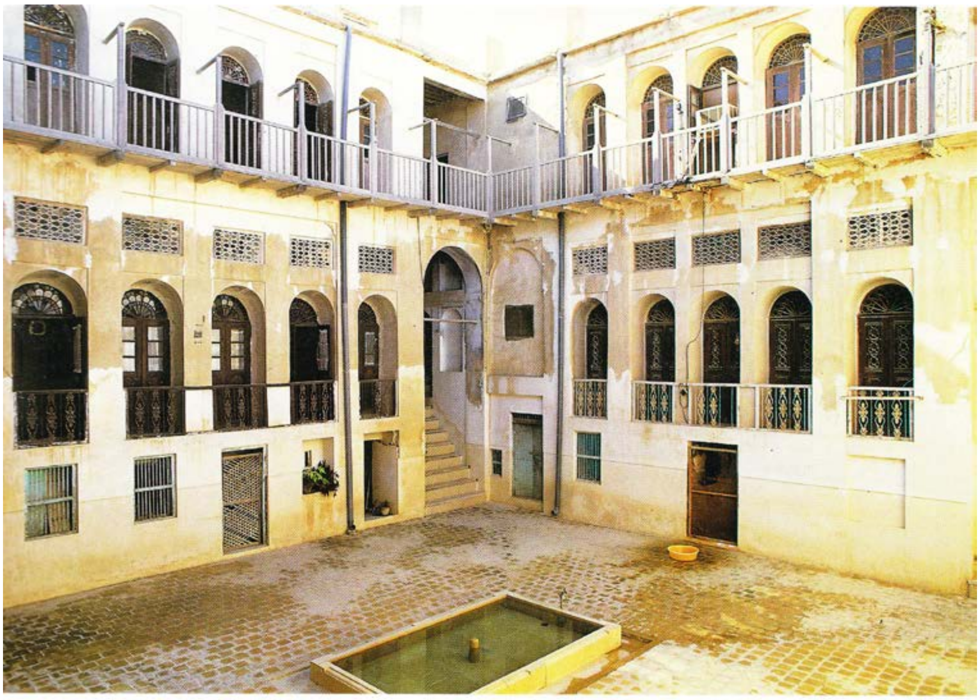


Scale 1:100 18 m x 12 m = 216 msq 3 living units, 3 bedroom plus a suit

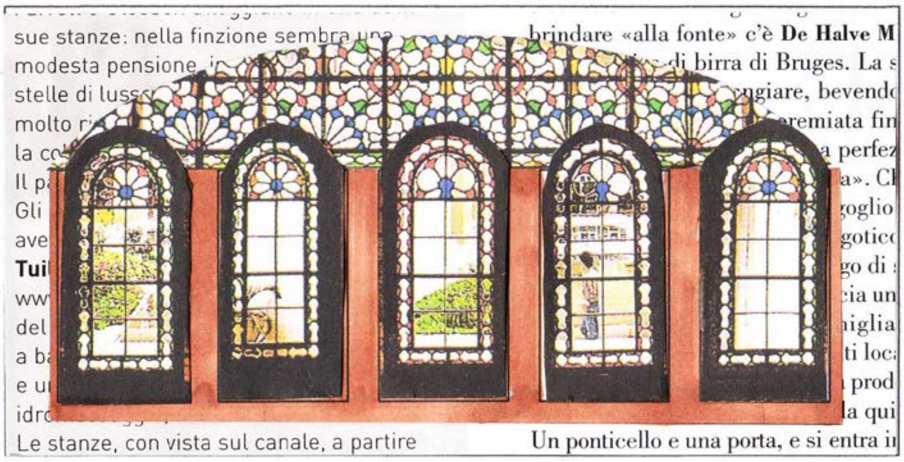
in our culture taking care of the single old grandma and grandpas is fine moral thing to do. this unit is suitable for these kind of situations. Also its not very accepted culturally for the sons and daughters to go live by their own, we have it in phrase, its better to live under the shadow of your family before making your own. But these days as the worlds transform the living ways are too. And making a family became a free choice of life. This living unit is a solution to live partially with the family yet keep your own space.
also in the rural architecture of Iran its possible to see the same samples of this kind of living space. usually a newly wed just move into a small suit next to the parents in order to get some help at the beginning stages of their life. Specially the house wife could learn the art of being a good wife while living next to the mother or in-laws.

Elevations:

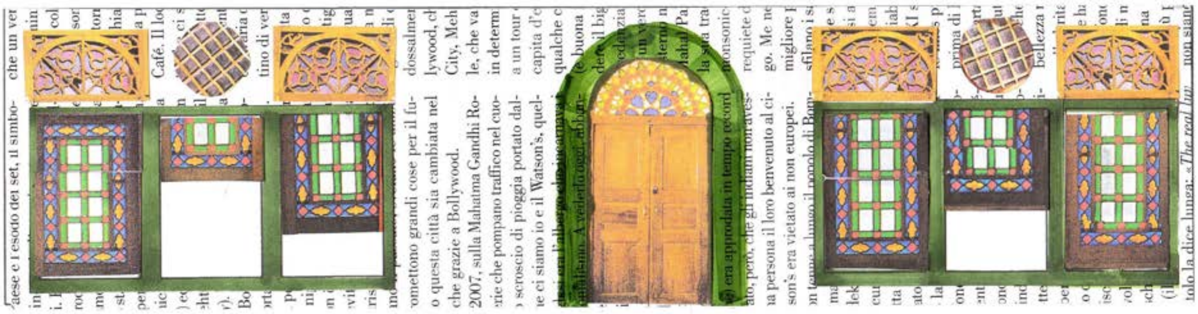
The elevations are designed with traditional principles, arches, and shapes of the windows are very similar to old houses.



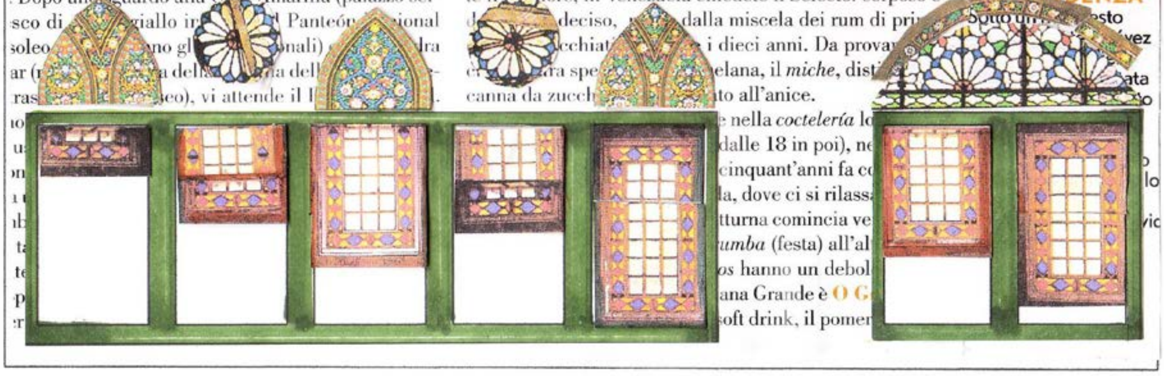
The use of traditional orosi look double glazed windows gives a very colourful cultured beauty to the elevations of the units. The windows slide upwards all the way and almost takes away any barriers between inside space and outside. The windows slide triple racks, so that they are not that heavy to work with also the user can control the amount of opening and light accordingly.



The 6 m x 12 m unit bed room elevation. Face either north east or north west. Walls are Recycled materials: card board or TPR. Plus the orosi double glazed windows.



The 9m by 12 m unit entrance elevation. Face either south east or south west depending on the location on the site plan.Walls are Recycled materials: card board or TPR. Plus the orosi double glazed windows and wooden old style entrance door.



The 9m x 12 m unit bed room elevation. Face either north east or north west. Walls are Recycled materials: card board or TPR. Plus the orosi double glazed windows.

The main elevation of the building may change through time. Since the units are flexible to move and change and replace. So according to use the elevation could change. Here is a typical elevation of the entrance and the bedrooms.

The Elevation of the entrances view to courtyard. It face south east or south west according to its location on the site. The ground floor is filled with necessary daily functions to a resident. Such as dry cleaning, food markets, pastries, food services or related…
Also other functions are provided according to the users, a multi functional hall to hold events, or any type of studios. The use also here is pretty flexible.

The elevation below is the elevation from the bedrooms. Face north west or north east according to where they building is placed in the site.

the left spaces between the units are going to be private semi open green spaces for the units. In iran due to iaslamic culture its not easy to use balconies due to the problem of the view by outsiders. But in this case these spaces are confined enough and yet to be more confined with vegetations so that the users can use them freely as private balconies.

Indoor partitions:

Japanese doors and movable partitions

We have a few types of doors available:

The Kura Doors are heavy and were used on storerooms that stored valuable items not on display in the main house. Due to their size and strength they make impressive dining tables.

The Yoshido Doors were also known as summer reed doors because they allowed cool breezes to ventilate a Japanese home. These were stored during winter and replaced the shoji and fusuma during the warmer months. Hinged together they make excellent screens.

Fusuma are panels which can slide from side to side to act as a partition within a room or as a door. They were traditionally painted, often with landscape or animal scenes. They typically run on wooden rails at the top and bottom and can be easily converted into a cupboard door or hinged to use as a working door.

"Tategu-shi" is a craftsman who makes mobile partition "tategu," mainly wooden doors installed inside of a house or at the house gate. Tategu-shi also produces "fusuma," sliding wooden and paper door installed in a house, as introduced in our previous blog.

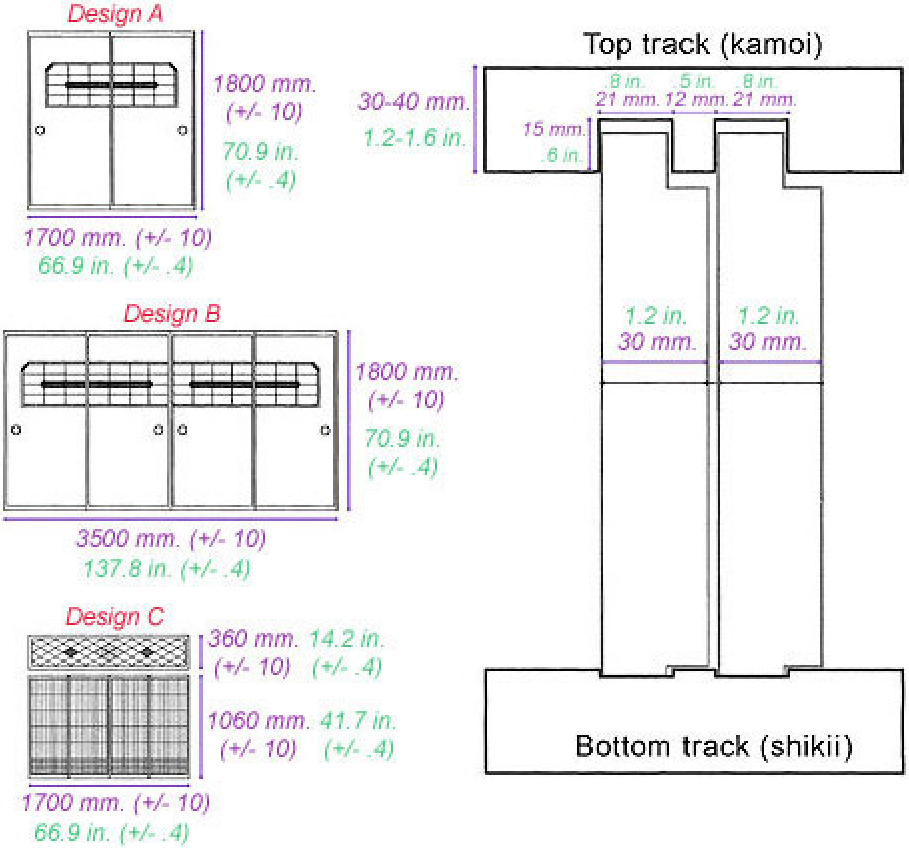
Originally, tategu was brought from ancient China as one of temple architecture. As time went by, it became to be used as the partition of dwelling space. Tategu also has other purposes: soundproof, heat insulation and decoration.

Kihara Fusuma, Focus Japan's parent workshop, mainly manufactures fusuma and byobu, Japanese folding screen. Fusuma is used rather for practical use in Japanese traditional houses, whereas byobu is for interior decoration.

Traditionally, delicate washi paper was used as the insert for shoji.
For practical reasons, Shoji Screens Australia chooses to use 3mm acrylic sheeting. The acrylic sheets are available in a matt finish. The modern acrylic sheeting is a durable, easily cleaned, long lasting product which still retains the integrity of the traditional shoji appearance and function. And you get the Kumiko designs (lattice) on both sides of your shoji.
It looks very similar to the Japanese plain shoji paper. In Japan they are also using PVC and acrylics in their new shoji.

Shoji are not limited to sliding screens. Other applications include:

- Free standing shoji
- Bi-fold stacking shoji
- Hinged shoji (doors)
- Skylight shoji
- Shoji walls
- Sliding window shoji for double glazing
- Wardrobe shoji



a typical interior space in a traditional Japanese house. As in the case of the akari-shoji doors which constitute the outer walls, the fusuma sliding doors, which partition off the interior space, are made of paper. The idea is of a temporary space in which the interior space as a whole is linked to the outside.

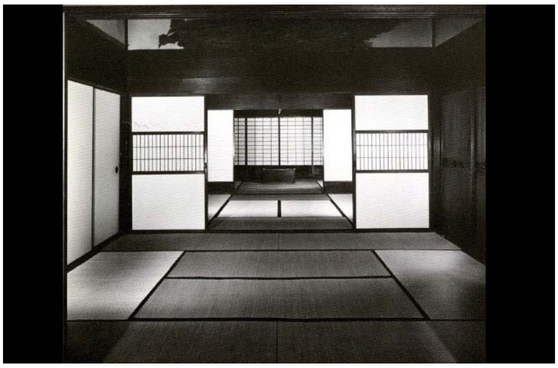
Human life and the universe continue to mutate constantly and are thought of as essentially impermanent. This sense surely originates in the Japanese climate, with its strong sensation of the four seasons. Spring eventually turns into summer, which in turn gives way to autumn and winter, when life temporarily sleeps. The Japanese aesthetic of impermanence is a reflection of such changes.

The sense of the temporary and transient (ka) reflects a willingness to live positively by entrusting oneself to the flow of nature while at the same distancing one self appropriately from nature. It comes not from a feeling of being resigned for the time being to the way things are but from a view of the universe and a sense of order which accepts that everything is essentially temporary and transient.

We see here an aesthetic awareness that is prepared to accept things as they are and is willing to trust to the flow of nature. This approach is wholly different from that adopted in the West, where life is conceived as being led in opposition to nature.

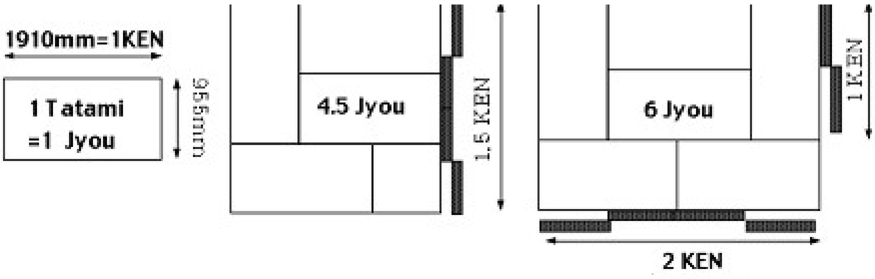
  

Fusuma: Sliding doors covered with a thick opaque paper or cloth on a wood frame grid, used to separate tatami rooms (wall to wall doors). Traditional doorways are usually about six feet high. They are often painted with beautiful natural scenery on one or both sides. Sometimes fusuma referred to as sliding paper doors. They usually could be removed to make a larger room or reception area out of two rooms. Think of a movable wall.
Shoji: Sliding doors covered with a thin paper, pasted over the wood grid and frame door. The wood is normally unfinished. They are usually six feet high. Shoji normally come in sets of four. The primary traditional function is to divide interior space from exterior space. In more modern homes they are used to partition areas where house slippers are worn from tatami rooms where house slippers are not worn.



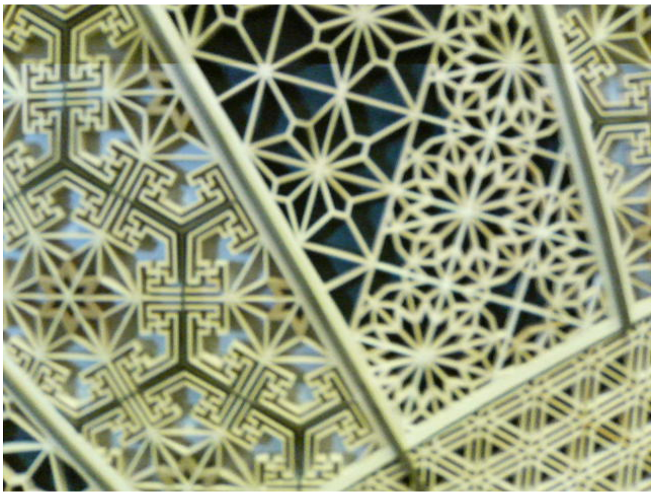
One of the most common elements seen in Japanese decor are sliding doors with translucent white paper mounted on the outer side of a wooden lattice. These doors are called shoji (pron. SHO-ji) in both Japanese and English. Shoji doors require railing slots above and below the door. The slotted beam above the door is called a kamoi beam, and the slotted rail built into the floor is called the shikii (pron. SHE-key-ee). Shoji doors do not have wheels under them, so they are carefully crafted to slide in their slots using a one-finger push. It is the careful fitting and very smooth finish of the wood that allows this.

Specialty Craftsmen
Shoji doors or windows are made by special craftsmen called tategu-ya. The word tategu is a general name for the sliding doors and windows that serve as wall openings in Japanese post & beam architecture. The word ya means “roof” or “shop.” So the complete term, tategu-ya, means “workshop for sliding doors” or the craftsman who works in that kind of shop. When addressing the actual artisan you would call him a tateguya-san.



The sliding doors and windows in a Japanese house can be removed from their rails and stored in a hallway or adjacent room. Taking the doors out makes the room bigger, more open, and better integrated with other spaces such as the garden. The practice of removing the doors is common whenever a big room is needed for events like parties and funerals. If you live in a Japanese house, there is no need to be shy about removing the doors, but you have to be a little careful too. The doors are somewhat delicate and each of them is likely to be slightly different than the others. You need to remember the order in which they came out so they can be put back in the same order. Otherwise, you might find that some of the doors do not slide so easily.

Shoji paper is made of traditional paper called washi. Some casual gaijin like to call it “rice paper,” but this is a myth. In fact, washi has nothing to do with rice. It is made from fibers from a tree called kozo, which is in the same family as the mulberry tree. The washi paper used for shoji screens is made with a specific thinness that allows just the right amount of light to go through. By changing the fiber direction and thickness, washi can control two opposing optical factors such as reflection rate and transparency. Shoji’s paper surface scatters sunlight evenly, making it soft to the eye and allowing light to distribute evenly. This function of washi makes it particularly suitable for indoor lighting fixtures such as Isamu Noguchi’s famous “Akari” lamp shades. Even at night, shoji screens help light a room as their white surface reflects indoor light and brightens the room. Shoji paper is thus quite remarkable: it has no glare problem, maintains privacy, and allows the light to enter in a pleasant way.

The design could be various and done either by hand or a 3d plotter. There fore its possible to adopt the door in any interior space with any interior design. In this case the of this residential complex, having arabesque and Islamic carvings would be very appropriate, or the choice could be the user's.

Movable walls

These have become today's most mobile and flexible wall system as their secret is making it possible to divide one room into several different ones with incredible sound insulation.
The two keywords of today modern world are time and flexibility. Using *moveable walls* you can separate one room into various small rooms and give them brand new functions in the nick of time. Operable partitions from specialists.

With movable walls aka soundproof walls you can divide a large room into many smaller ones and turn it back into a big room again whenever you need to. Have a party in one room and put your children to sleep in the other - the walls are perfectly soundproof! Change the appearance of your rooms every day - your imagination is the limit!

Folding walls:

Folding walls or sometimes called as folding partitions?are basically movable hinged panels that have absolutely amazing sound insulation ability. It is now easy to create new rooms and spaces with different functions and for different purposes. The parking area? of the wall panels is at the end of the wall tracks. The walls cannot be parked off the track.

You can order folding walls with upper track system or bottom track system. In case of upper track system the possible weight of the panels depends on the upper track fixings.

The tracks are held by adjustable brackets and there is always a possibility to add bracket length with metal tubes and diagonal fixings. No floor tracks are needed with the upper track system.

The bottom track system uses floor tracks and an upper guiding track. This system is recommended for usage in such spaces where it is not possible to hang heavy panels.

Construction of panels:

The thickness of the folding wall panel is 80 mm. A wide range of materials is used for acoustic isolation. All the panels are framed with anodized aluminium, which gives the panels a touch of elegance and strength.

Surface decorating materials:

Hundreds of different materials can be used on folding wall surfaces - paint, veneers, fabric, metal sheets, laminate etc. There are also thousands of possibilities to mix different materials to get the most unique and elegant look for your walls.

Fire safety is an area of growing concern in the construction industry. In certain applications, an operable partition must not only control sound, but maintain a fire rating as well. To answer this challenge, the only manufacturer of acoustically rated, UL listed fire safety products; in both accordion and flat panel operable partition configurations. We can also deliver fire-rated movable, operable and folding partitions..

Care and maintenance

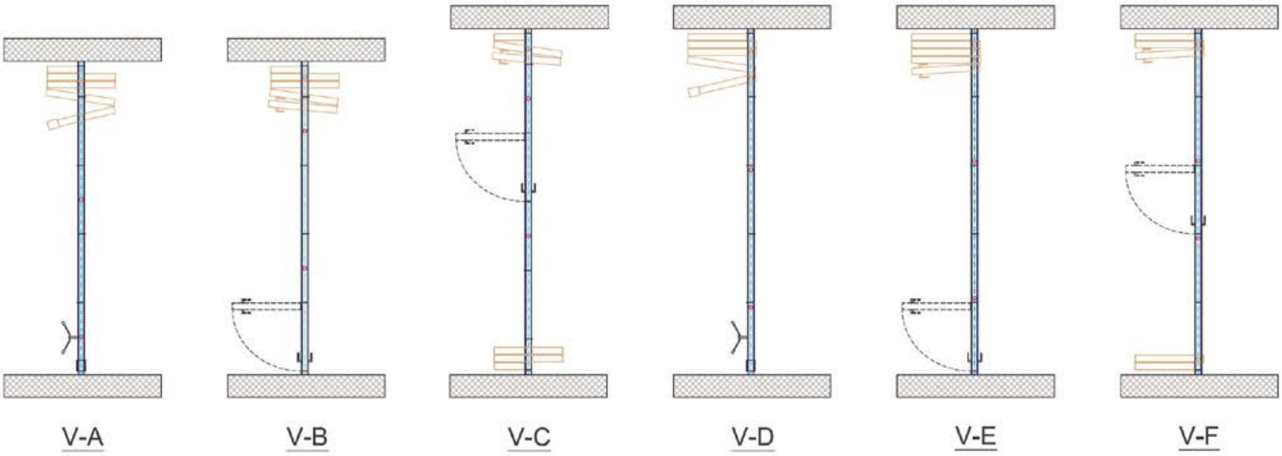
The aluminium carrier tracks do not rust and need no lubrication. Wheel ball bearings are self-lubricating.

Special solutions:

Panels are available with window elements and pass doors that make the usage of the wall more flexible and easier. Standard panels are framed with anodized aluminium but it is also possible to paint them according to the RAL-color catalogue. There are a wide variety of details to be used to make the panels look more powerful or elegant.

Installation

Installation of the movable walls is quick, easy and economic. A track system needs to be fixed with the included special adjustable brackets. If there is a space wider than a 150 mm between the track and the ceiling, it is necessary to install additional metal tubes to hang the whole system.

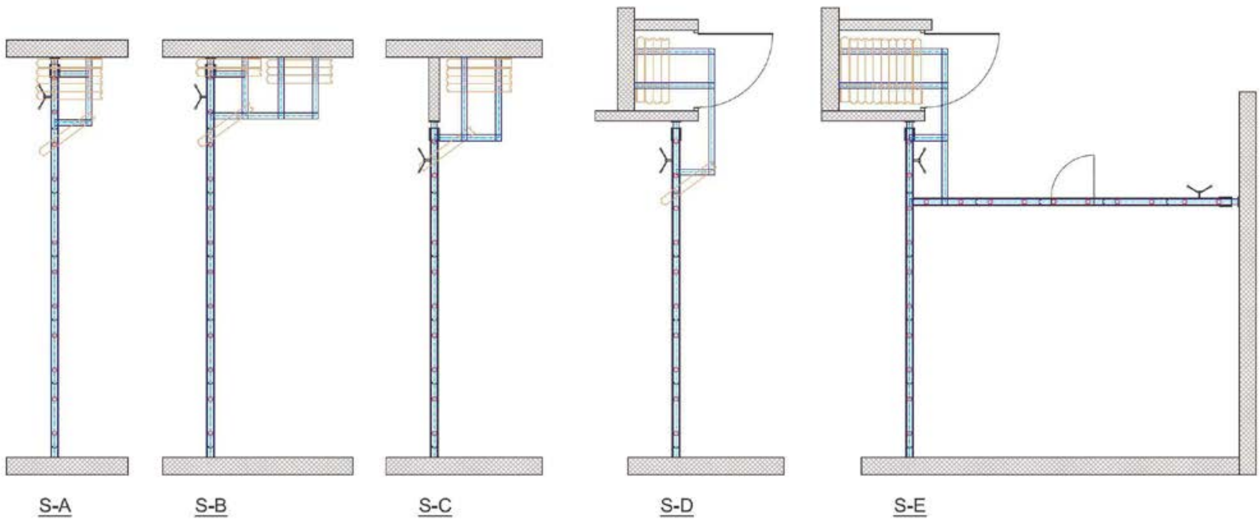


Paired panel partitions

When remote storage is not required, our center-hung panels hinged in pairs are the ideal solution because they set up or stack quickly. Optional hinging is available to accommodate moldings or other decoration. Acoustic ratings are the same as for individual panels.

Operable walls:

Operable walls form the most flexible wall system in the selection of movable walls. There are no hinges, no floor tracks and no limits to park elements. You can park the panels in the other room if you like, using upper track system. You probably wonder whether it is possible to install such walls after your rooms have already been finished by the architect. the answer is a definite yes! You never know when you might need to rearrange your rooms by creating additional space. operable walls give you the opportunity with no significant effort and labour.



Optimally to use the available space, requires variety of selectable panel types. Standard panels, and telescopic panels to realize wall connections, request modern architecture fundamentally only. Corner panels enable crosswise the displacements to the partition. Standard angles of 45 degrees and 90 degrees understand themselves as suggestions other conceptions are able. Door panels provide for constant of separated spaces. Opening width up to 1000mm to meet technical demands at the building. Complicated sketches by T-panels are implemented. Our partitions received transparency by glass windows. Pivot doors complete the supply. For the separate storage of panels a pocket door is an optimal solution. Surface-to be flush with the wall, it enables a smooth termination.

Telescopic elements:

All partition panels will be locked with telescope system to create magnificent sound insulation. Only 1/3 of a turn is needed to open or close. There are no mid-positions - the bottom and top telescopic seals cannot be accidentally left in partially “closed” positions to rub against the floor. The vertical edges at both ends of the panel are the same - there are no male and female parts - making fitting together quick and easy.

Track system:

Operable walls come only with the upper track system. The tracks are attached to adjustable brackets and there is always a possibility to add bracket length with metal tubes and diagonal fixings. No floor tracks are needed with the upper track system.
There are one or two special rollers on each panel, which help to achieve the smooth rolling in the track.

The panels are really easy to move due to plastic-coated carrier wheels equipped with ball bearings enable movable partitions to be operated easily and silently. In tracks with many angles, horizontal double carrier wheels add movability at intersections and angles.

Construction of panels:

The thickness of an operable wall panel is 85-100mm (depending on the level of sound insulation). A wide range of materials is used for acoustic isolation. All the panels are framed with anodiazed aluminium (except the 50dB wall in which case concealed aluminium frame is a standard solution), which gives the panels a touch of elegance and strength.

Surface decorating materials:

You can use hundreds of different materials creating the surface of the operable wall - paint, veneers, fabric, metal sheets, laminate etc. There are thousands of possibilities to mix different materials to get the most unique and elegant look for your walls.

Special solutions:

Panels are available with window elements and pass doors, which make the usage of the wall more flexible and easier. Standard panels come with an anodized aluminium frame but it is also possible to paint them according to RAL colour catalogue. There are a wide variety of details to be used to make the panels look more powerful or elegant. Two movable partitions may be placed at 90 degree to each other. Curved walls can be assembled using angled track sections. We also offer fireproof movable walls.

Installation

If building deflections makes operating a movable partition difficult, the height of the track can be adjusted with supports in order to free the partition.

Installation of the movable walls is quick, easy and economic. A track system needs to be fixed with the included special adjustable brackets. If there is a space wider than a 150 mm between the track and the ceiling, it is necessary to install additional metal tubes to hang the whole system.

Standard ceiling support and track encasement profiles can also be suspended from the track without special solutions.

Care and maintenance

The aluminium carrier tracks do not rust and need no lubrication. Wheel ball bearings are self-lubricating. Aluminum frames protect the faces of the panel from being dented. Panel faces may be changed on the spot, if needed - they do not have to be sent to the factory if they are damaged or changed for a new style when required.

Q: How much does the panel weights?

A: Panels weight depending on type 35-55kg/m2, but thanks to the magnificent sliding mechanisms there is no weight problem. To move the panels you have to only push them or slightly drag them and all panels will slide very easily.

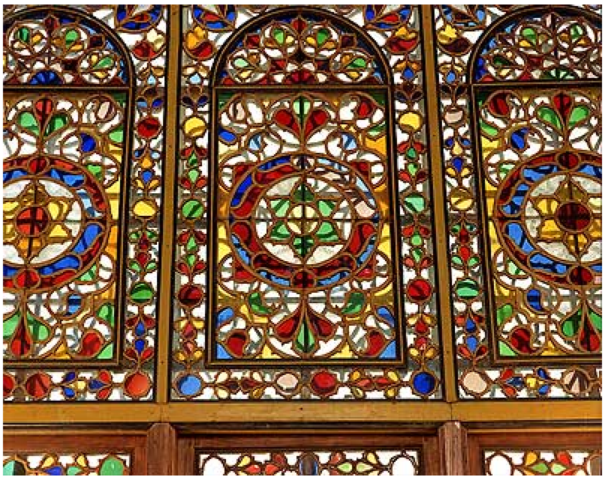
Q: Can I manage the installation process?

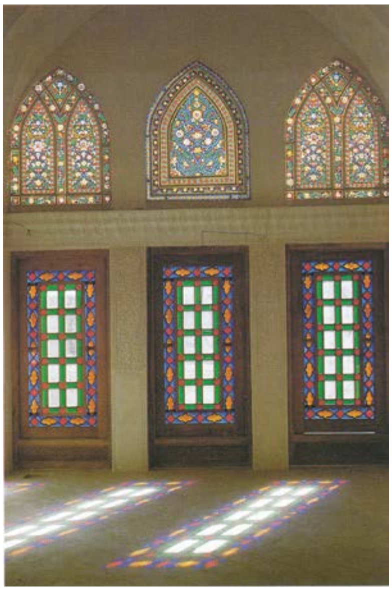
A: In case of installation there are very important to do it by the manual. You have to carefully read the installation manual and then there will be no problems. If you just now something about construction, there will be absolutely no problems installing the movable walls.

Q: How do I clean and treat the panels?

A: There are no necessary treatment measures to the movable wall. Only just once a year you have to clean the track and put some lubrication on the track.

Since the panels could be design in any style, for this project I suggest the traditional designs with use of lots of glass, colourful and transparent, so that the light would flow through the spaces from the cross windows on both side of each unit.





The orosi windows:

orosi is a traditional iraninan window, with a wooden frame and netted, which slide vertically. And the hight of it is from the floor to the ceiling. It opens in half of course. some part of it can have no glass as well. its one of the most traditional windows in Iranian architecture. It has colourful glasses and nice wooden design. The netted design help reducing the amount of life and works as sun shading element. At the same time it helps reducing the view from outside to inside of the rooms, it creates privacy, which is a very important characteristic in an Iranian home. The colourful glasses keep the insects away. as researches show the colourful reflections keep insects away. these windows make a beautiful fecade outside and a delightful effect on the light inside. Each of these colors make a specific psychological effect in the space. the main colours are blue, red, yellow and green. They have been used all in a harmonical amound that each completes and moderate the effect of the other ones. The geometrical shapes of the wooden nets on the window and the simple pieces of coulorful glass make a very simplified beauty. Since in Islamic art to draw images of people and animals have never been that common and appreciated, the Islamic arts and architecture always lean towards the geometrical shapes and abstract. In an orosi this artistic play with natural shapes and colours is very obvious. If the pieces on a surface have different angles in ratio to each other, it displaces the sound as we know in acoustics. Specialy the hexagonal shapes reflect the sound away.

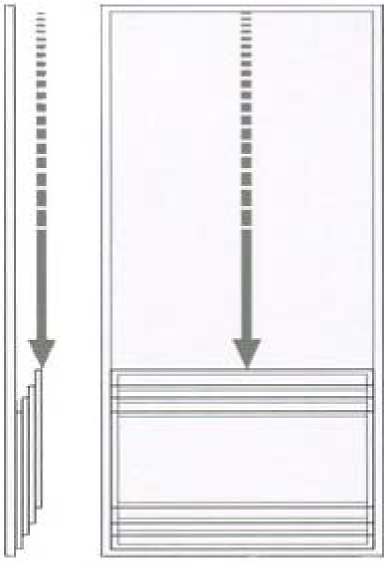
like the natural example, the bee house. The different subtracted or prominent geometrical shapes on the wooden net of the orosi produce an acoustic isolating property in the space.

Orosi example from a palace

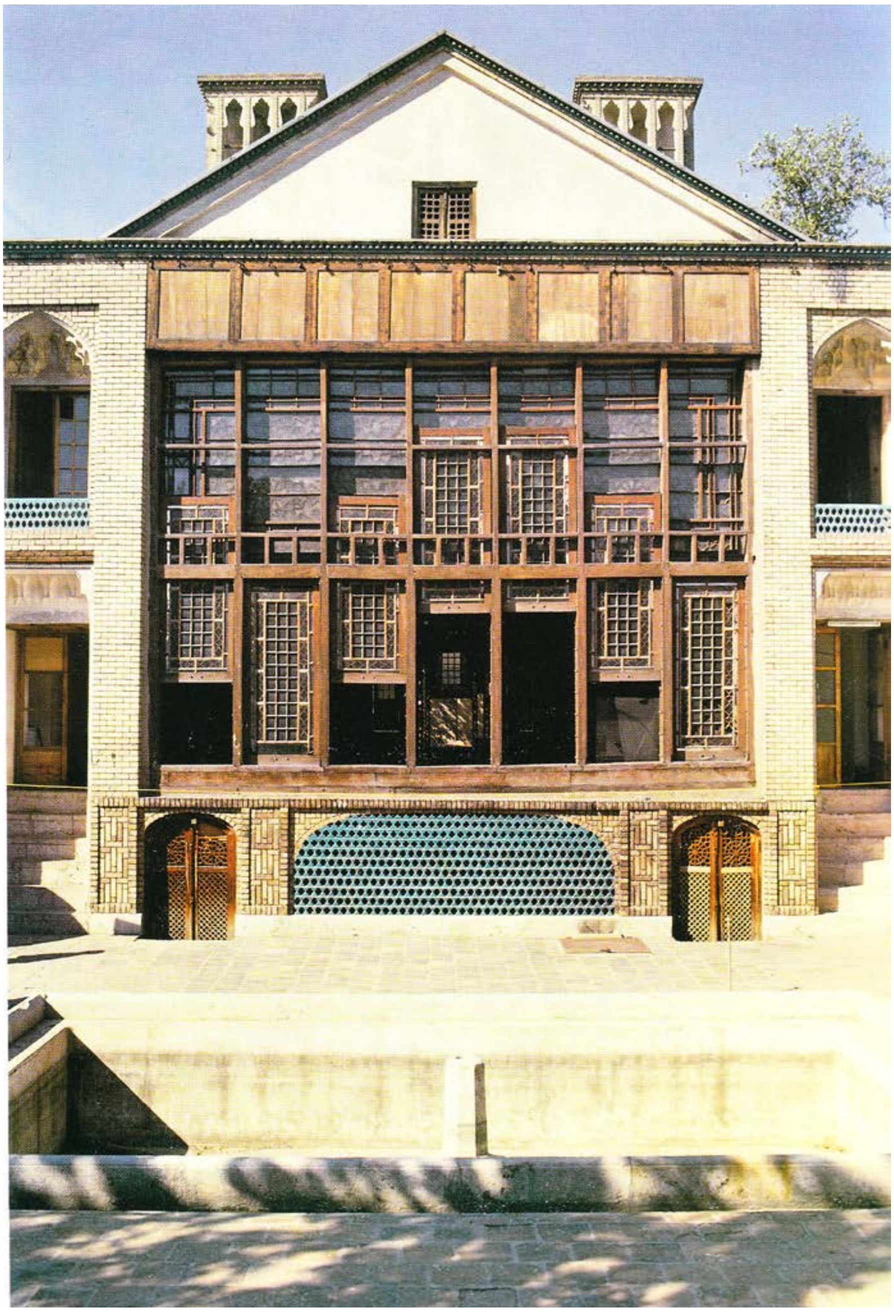
Simple wooden orosi

Orosi from a rural house

Triple track sliding widows:



If you desire a wider than normal opening, you can have the option of utilising a triple track system that allows multiple sliders to open in the same direction at once, giving the potential up to two thirds opening aperture.



Double glazed windows are used, but covered with a pvc frame on the outside carved like the orosi old look. The orosis open all the way up. But in this project for the sake of simplicity of opening and closing the windows without having trouble with the weight they divided to 3 parts sliding down. in this way the user can control the amount of opening according to their desire. These kind opening helps keeping a stronger relationship between inside and outside, specially in this site, where the nature is very rich and beautiful.

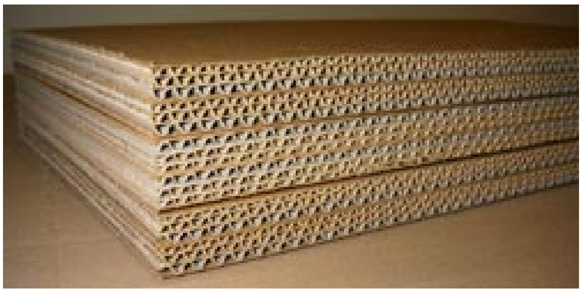
Suggestions for internal wall’s materials:

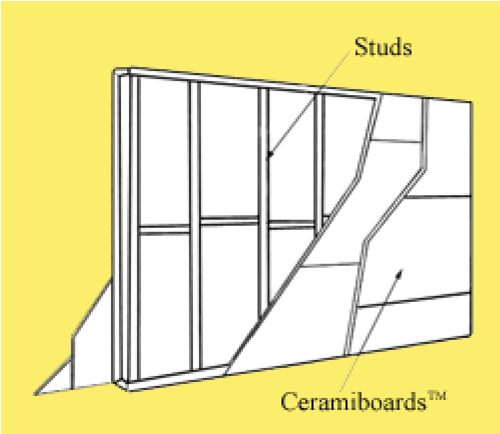
CeramiBoards:

CeramiBoard is a revolutionary corrugated cardboard building product with excellent:

- Fire resistance
- Acoustic properties
- Thermal properties
- Mechanical strength
- Fixing capabilities
- Cost Competitiveness
- Environmental Qualities

CeramiBoard has a variety of uses including:





- Fire rated walls

-Fire resistant ducts

-Super strong cardboard boxes

-General purpose wall panels

Corrugated cardboard possesses many features that are desirable in a building material such as light-weightness, stiffness and thermal insulation value at low cost. Preventing the widespread use of cardboard as a building material have been deficiencies in three areas, namely:

- strength
- fire resistance
- sound transmission.

CeramiBoard addresses these concerns, in that it has good strength, fire resistance and sound transmission qualities. These attributes are sufficient to allow significant penetration of the huge world market for internal walls, especially those between residential units where minimum fire and sound performance is mandatory.

The product can be encapsulated in a tough plastic film to provide water resistance required for external use. Such technology already exists, having been developed by major cardboard producers in Europe.

In addition to panels for housing, CeramiBoard can also be used to upgrade the technical properties of cardboard to allow use in areas where it could not otherwise be specified. An example in this regard are electrical cable trays, which benefit from the low electrical conductivity, high heat resistance and thermal barrier effect provided by CeramiBoard®, compared to standard steel trays. Even in the traditional area of use for corrugated cardboard i.e. boxes for packaging, the

CeramiBoard® process can produce boxes that are almost indestructible, giving a much longer service life from each box, as well as better protection.

In conclusion, judging from the positive test results obtained by independent institutions, and overseas and local interest in the concept of using cardboard as a building material, it is reasonable to expect a commercially successful future for CeramiBoard, the recycleable cardboard building product with excellent fire resistance sound proofing, thermal and environmental qualities.

Face Brick veneer panels:

Face Brick made from cement, aggregate, quartz sand, and cured mineral oxide colors.
Can be used for exterior and interior, Water-proof, frost-proof.

- ☐ Easy material handling and transport
- ☐ Stronger than natural Slate slabs by penetration the Slate Lite with polyester
- ☐ Large formats available (2510 x 1050 mm)
- ☐ Dimensionally stable, according glass
- ☐ Reduces the weight of buildings
- ☐ Adhesive systems for many applications available
- ☐ Environment-friendlier than when you use natural stone
- ☐ Easy to handle with DIY tools (sawing, drilling, cutting)

Create soft, neutral brick face accents to both indoor and outdoor settings, without the help of professional masons or the labor of brick-laying! Traditional brick can be fragile and difficult to work with, but our faux brick panels give you unmatched ease and durability. Each faux brick panel is 24 inches tall, 48 inches wide, and 1/2 inch to 5/8 inch thick and comes in an easy-to-install interlocking design. Just slide the panels together for a seamless tan brick finish!

Size	60 cm Tall x 120cm Wide x 3cm Thick
Weight	Approximately 2.267 kg per faux brick panel
Interior Use	Highly Durable, provides good R value (5)
	ASTM E-84 Class A Fire

Suggestions for exterior walls material:

TPR:

Recycled Building Material Stronger than Concrete: A new building material has the potential to divert large quantities of waste from landfills.

UK company Affresol offers a truly novel building material called Thermo Poly Rock (TPR), which is made from select waste products. The resulting material is stronger than concrete, is waterproof, fire retardant, and can be used to build low-cost modular housing. Each house built with TPR panels will save an average of 18 tons of waste material from being disposed of in landfills.

"Every country in the world has issues with waste and we now have an opportunity to turn waste into an enduring housing resource that is 100% recyclable." - Ian McPherson, Affresol

TPR is cold-produced from waste products mixed with resin and polymers which can then be poured into molds like concrete.. Once cured, the company says that TPR offers great thermal insulation, is not subject to insect infestation or rot, does not leach any dangerous chemicals, and is 100% recyclable. The company also states that TPR panels have better flex and tensile characteristics than concrete, and the panels can be manufactured to different grades of strength as appropriate to the end use.

The TPR panels can be used to frame houses, saving large amounts of lumber in the building process, and because the material is waterproof, houses can be put up year-round. The panels are molded at the factory and transported to the site once construction begins, which can greatly speed up the building process - taking less than a week to build the entire structure. According to Affresol, houses built with TPR panels also cost less than traditional building methods.

In addition to being environmentally friendly, the Affresol house is targeted to lower income families, offering "a real and cost effective opportunity to the thousands of people who are currently unable to get onto the first rung of the housing ladder".

TPR3™ is a “thermo set polymer” that is produced from a cold process that takes selected waste products that have been diverted from landfill. This pre selected waste is recycled then size reduced, after which it is mixed with a Resin and the TPR Polymers. The result is a mouldable liquid compound that is poured like concrete and when it is cured is stronger than concrete.

The waste streams that will be used in this process will all be diverted from landfill.

TPR3™ is poured into moulds in the same way as concrete and will be left to cure for 24 hours. When TPR3 is in its solid form it has the following intrinsic attributes:

- TPR stronger than concrete,
- TPR has excellent thermal insulation characteristics;
- TPR is very durable (estimated at 80 years);
- TPR is water proof;
- TPR is fire retardant;
- TPR is not susceptible to insect infestation;
- TPR does not rot.
- TPR does not leech any harmful elements
- TPR has a “Low Carbon Footprint”
- TPR is 100% recycleable.
- TPR has better flex and tensile characteristics than concrete.

Thermo Poly Rock (TPR) can be manufactured in different strength grades and the strength grade is denoted by a suffix.
Detailed below are the current product strength grades.

- TPR1 - Compressive strength range 12 N/mm2 to 18 N/mm2.
- TPR3 - Compressive strength range 28 N/mm2 to 38 N/mm2.
- TPR5 - Compressive strength range 58 N/mm2 to 82 N/mm2.

The U Value is 0.174 and the thickness cant be thinner than 20mm. house frame panels are approx 2.5m x 2.1m so we make quite large sections (similar to old fashioned concrete pre-fab). They can be drill through and use threaded rod for jointing or you can use concrete screws and screw straight into it, also just used wood screws to fix straight into the material, the pull out force for the concrete screws was approx 16KN force.
designs are for 3 main products, House frames compare to timber frame, Sectional garages compare to concrete garages and Outbuildings compare to concrete so have different fixing methods. The house frames use threaded bar and silicone to joint horizontally and vertically and are fixed to the slab. The material is also lighter than concrete. It is still quite dense at 1500kg per M3 density of concrete is circa 2400kg per M3 in situ. It can be made still lighter, depending on the feed material.

Cardboard :

The chic cardboard house is no longer the domain of hobo's and bums, but is now being called the *Home of the Future*. The idea of the cardboard home was to get away from technology and create a home with the most simplistic ideas. Cardboard is 100 percent recyclable. The first luxury cardboard home is being worked on in Australia.

Some people may think it is a crazy idea because there is no other place where cardboard is used to build a home. All of the materials that will be used in the home will be recycled. Of course there will still be reinforced walls and some insulation. The only great part about a cardboard home is that

it is recyclable and the toilet is a composting system that only produces a nutrient rich water that is used for gardening.
According to the website housesofthefuture.com.au, this house is 85 percent recycled materials are used. By creating a home form cardboard it will save 12 cubic meters of landfill, 39 tress and over 30,000 liters of water. There is only a 12 volt battery or a small photovoltaic cell for a power generator. This will cut on energy bills and save conserve energy.

100% recycled materials with a waterproof outer membrane made of HDPE plastic.

There is also Designed by architects Cottrell & Vermeulen and completed in 2001, the building is a permanent educational and community space and an excellent example of sustainable school design.
Cardboard panels and tubes are the two basic building components. The tubes are used as structural columns and the walls and roof are made from load bearing and insulating timber edged cardboard panels. building is designed to have a life expectancy of 20 years.

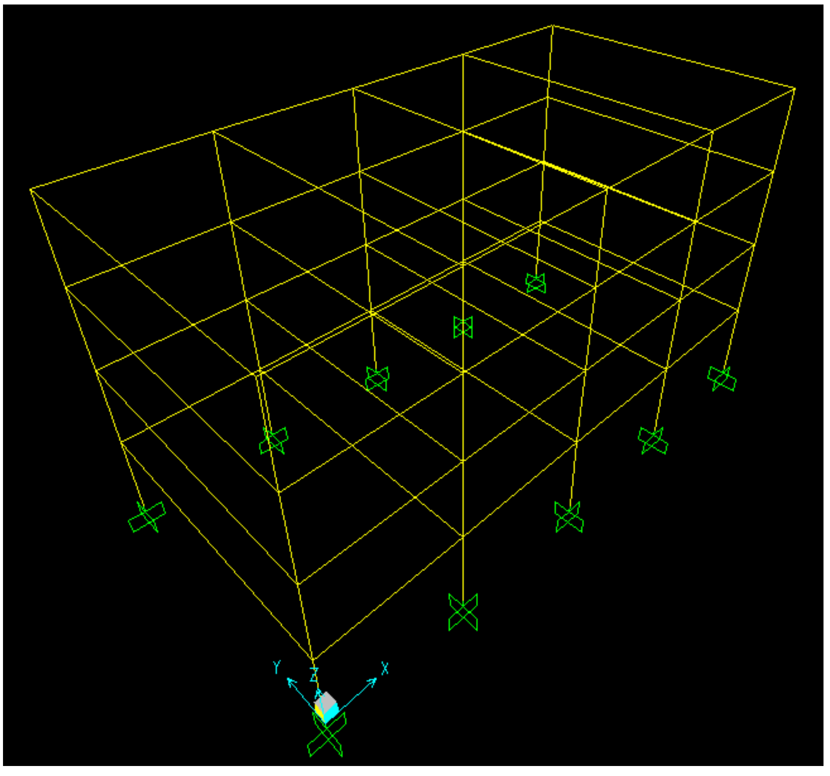
The Cardboard Building is the first project to win two RIBA special awards – the Stephen Lawrence Prize sponsored by the Marco Goldschmied Foundation and The RIBA Journal Sustainability Award in 2002.


The judges of RIBA award said,
"We were completely won over by The Cardboard Building for Westborough Primary School. It is Europe's first permanent cardboard structure, providing a much needed educational and community space as well as an inspiring structure that works with the properties of the material. Designed to last 20 years, the building's layout is inherently flexible allowing a wide range of uses within the main space. It combines the vision of the school's staff and governors with the tenacity of the architect and engineer to research the structural aspects of the project and obtain the necessary permissions from a sceptical Local Authority.

Structure:

The outer structure has been decided to be made out of steel frames, because of its velocity of construction, low cost, light weight, low maintenance required, and as most of the materials used on the project, is a recyclable material.

Also for the modular nature of the project, steel frames are more friendly for these changing units, and their connections to this outer structure.



Loads:

The loads used for this project where obtained from the Iranian construction code.

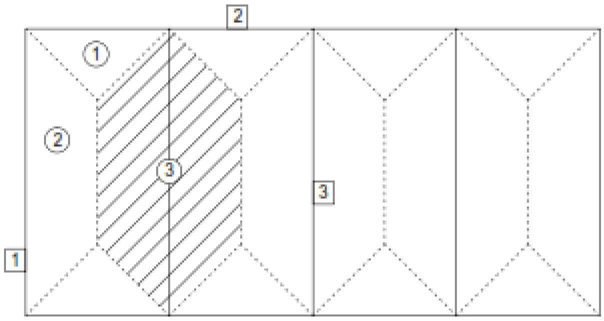
Live load on roof: 1 kN/m^2

Live load on the circulation area: 4 kN/m^2

Snow load: 1.2 kN/m^2

Dead load due to living units: 4.5 kN/m^2

And to know the load that each part of the structure will need to withstand, was done by calculating the tributary area of each one, ending up with 3 different beams.



Tributary areas

1 = 9 m^2

2 = 27 m^2

3 = 54 m^2

Distributed loads by beam type:

Beam number 1:

Live = 1 kN/m^2 * 9 m^2 / 6 m = 1.5 kN/m

Snow = 1.2 kN/m^2 * 9 m^2 / 6 m = 1.8 kN/m

Beam number 2:

Live = 1 kN/m^2 * 27 m^2 / 12 m = 2.25 kN/m

Snow = 1.2 kN/m^2 * 27 m^2 / 12 m = 2.7 kN/m

Beam number 3:

Live = 1 kN/m^2 * 54 m^2 / 12 m = 4.5 kN/m

Snow = 1.2 kN/m^2 * 54 m^2 / 12 m = 5.4 kN/m

Slab beams:

Beam number 1:

Live = 4 kN/m^2 * 9 m^2 / 6 m = 6 kN/m

Snow = 4.5 kN/m^2 * 9 m^2 / 6 m = 6.75 kN/m

Beam number 2:

Live = 4 kN/m^2 * 27 m^2 / 12 m = 9 kN/m

Snow = 4.5 kN/m^2 * 27 m^2 / 12 m = 10.13 kN/m

Beam number 3:

Live = 4 kN/m^2 * 54 m^2 / 12 m = 18 kN/m

Snow = 4.5 kN/m^2 * 54 m^2 / 12 m = 20.25 kN/m

Combinations:

The load combinations for designing the steel profile to use where done on the beam type 3, since is the longest and with the larger tributary area.

Also they were calculated on the roof and on the story slabs since the live and environmental loads are different in both of them, and in order to find the biggest load.

Roof: live load + 0.85 = 4.5 + 5.4 (0.8) = 8.82 kN/m

Slabs: dead loads + live loads = 18 + 20.25 = 38.25 kN/m → **to design**

Predesign:

Was done with the formula:

$I \geq 5/384 * 200\ PL^3 / E$

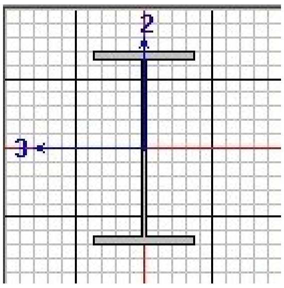
Where:

I = required moment of inertia for the section
P = design distributed load.
L = length of the beam
E = Young modulus of steel ($0.2_E{}^9$)

Obtaining:

$I \geq 5/384 * 200 * 38.25\ (12)^3 / 0.2_E{}^9 = 0.00086 = \boxed{8.6_E{}^{-4}}$

Section to choose: **HE600A**



Dimensions:

Outside height:	0.59
Top and bottom flange width:	0.3
Top and bottom flange thickness:	0.025
Web thickness:	0.013

$I = 1.41_E^{-3} > 8.6_E^{-4}$

Wind load

Was calculated based on the Eurocode *prEN1991-1-4.6:2002*.

With the equation:

$$v_b = c_{dir} * c_{season} * v_{b,0}$$

Where:

c_{dir} = Directional factor, recommended as 1,0

c_{season} = Seasonal factor, recommended as 1,0

$v_{b,0}$ = Fundamental value of the basic wind velocity, that we obtain from the national annex. At the bottom of mountains we use 21 m/s.

$$v_b = 1,0 * 1,0 * 21 \text{ m/s} = 21 \text{ m/s}$$

Peak velocity pressure at height **z**:

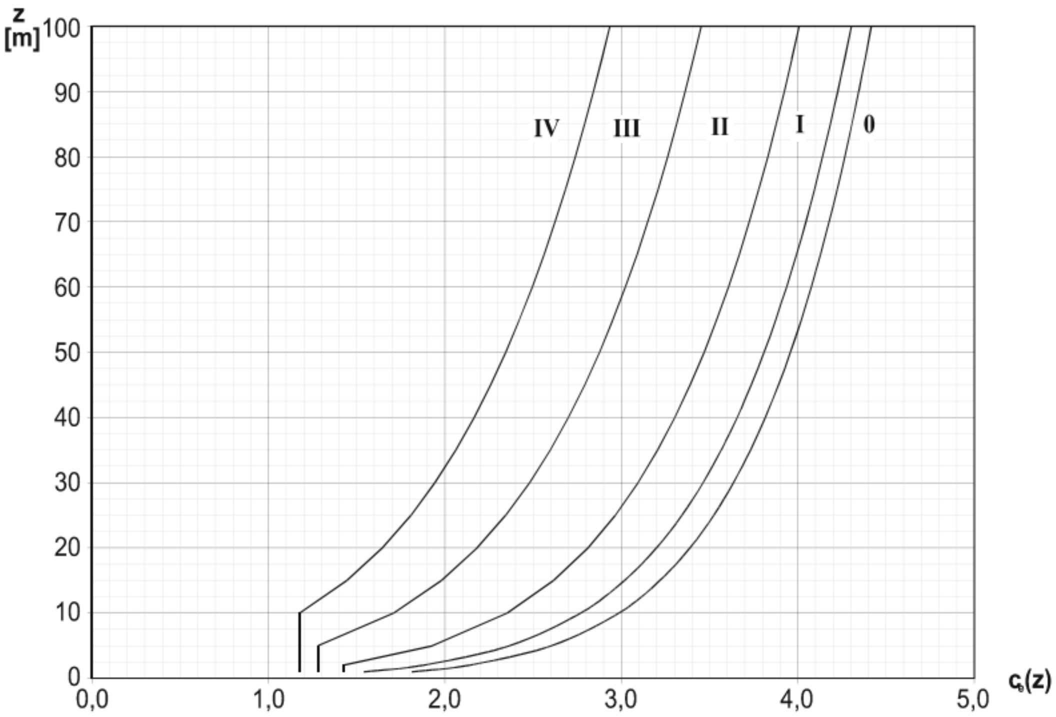
$$q_{p(z)} = [1+7*I_v(z)]1/2\ \rho * v_m^2(z) = c_e(z) *q_b$$

Where:

ρ = Air density, recommended value of 1,25 kg/m^3

q_b = Basic velocity pressure = 1/2 $\rho * v_b^2$ = 1,25*21^2 = 275,63 Pa

$c_e(z)$ = Exposure factor = $q_p(z) / q_b$; obtained from the following graph



For a 16m high building on a category I zone, the exposure factor is 3,1.

$$q_p(z) = c_e(z) * q_b = 3{,}1 * 275{,}63 = 854{,}45 \text{ Pa}$$

Roughness length (z_0) = 0,01 m
Minimum height (z_{min}) = 1 m
Maximun height (z_{max}) = 200 m
Height of the building (z) = 14 m : $z_{min} < z < z_{max}$
Therefore

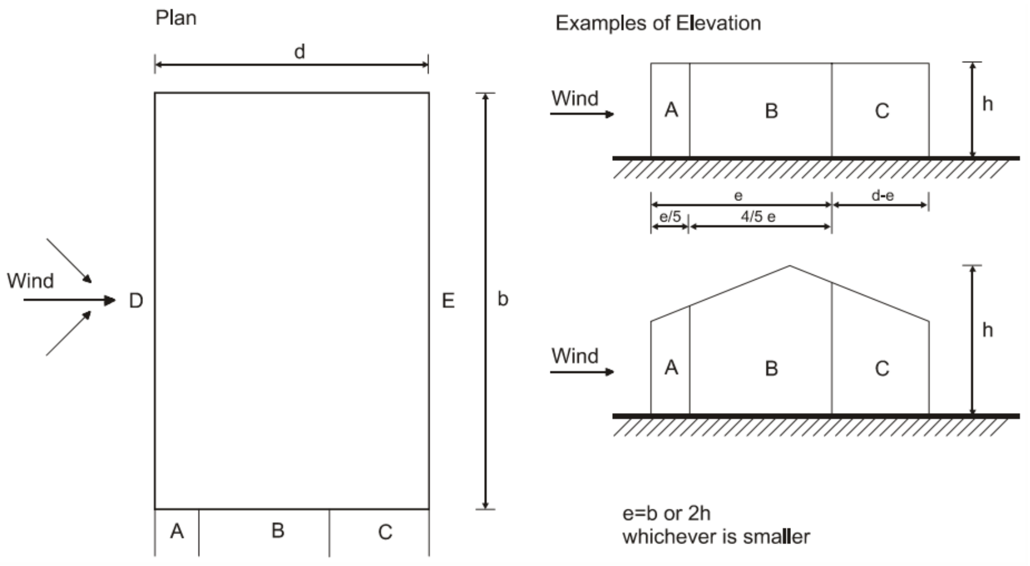
$$c_r(z): = k_r * \ln(z/z_o)$$

Where k_r:

$$k_r = 0{,}19 * (z_0/z_{0,II})^{0,07} = 0{,}19 * (0{,}01/0{,}05)^{0,07} = 0{,}17$$

$$c_r(z): = 0{,}17 * \ln(16/0{,}01) = 1{,}25$$

External pressure (C_{pe}):



We obtain the external wind pressure w_e by multiplying these coefficients by the characteristic peak velocity pressure (q_p).
The wind force acting on the area is got from:

$$F_w = c_s c_d * c_f * q_p (z_e) * A_{ref}$$

Where:
$c_s c_d$ = structural factor = 1,0
c_f = force coefficient for the element = 1,0
$q_p(z_e)$ = calculated before.
A_{ref} = reference area.

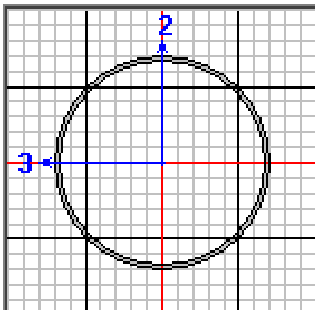
With the help of the software Excel is developed a table to determine the wind force applied to each column.

	length	height	area	Cpe	q(p)	We	F (Qk) kN	(qk) kN/m2	total length	kN/m
A	2.400	16.000	38.400	-1.200	854.450	-1025.340	-39.373	-1.025	48.00	-0.82
B	9.600	16.000	153.600	-0.800	854.450	-683.560	-104.995	-0.684	16.00	-6.56
C	12.000	16.000	192.000	-0.500	854.450	-427.225	-82.027	-0.427	16.00	-5.13
D	12.000	16.000	174.000	0.800	854.450	683.560	118.939	0.684	32.00	3.72
E	12.000	16.000	174.000	-0.515	854.450	-440.042	-76.567	-0.440	32.00	-2.39

The highest load applied to the columns is 6.56 kN/m, therefore:

$$I \geq 5/384 * 200 * 6.56\ (4)^3 / 0.2_E{}^9 = 0.0000055 = \boxed{5.5_E{}^{-6}}$$

The choice is to use a circular steel profile with the following measures:



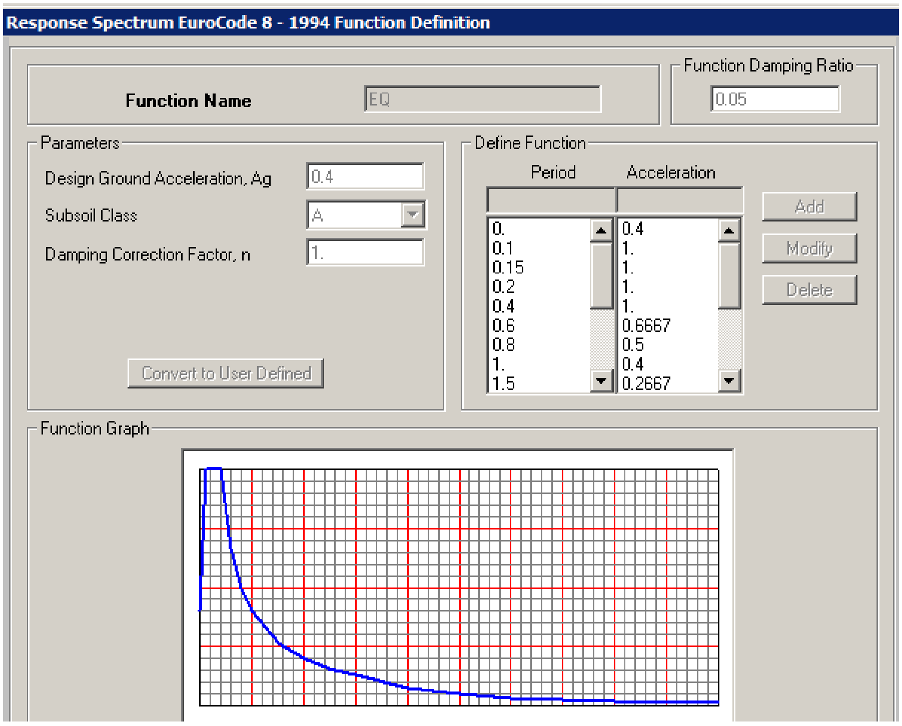
Outside diameter: 40 cm

Wall thickness: 1 cm

$I = \pi (D_E^4 - D_I^4) / 64 = \pi (0.4^4 - 0.38^4) / 64 = .0002331 = 2.3_E^{-4} > 5.5_E^{-6}$

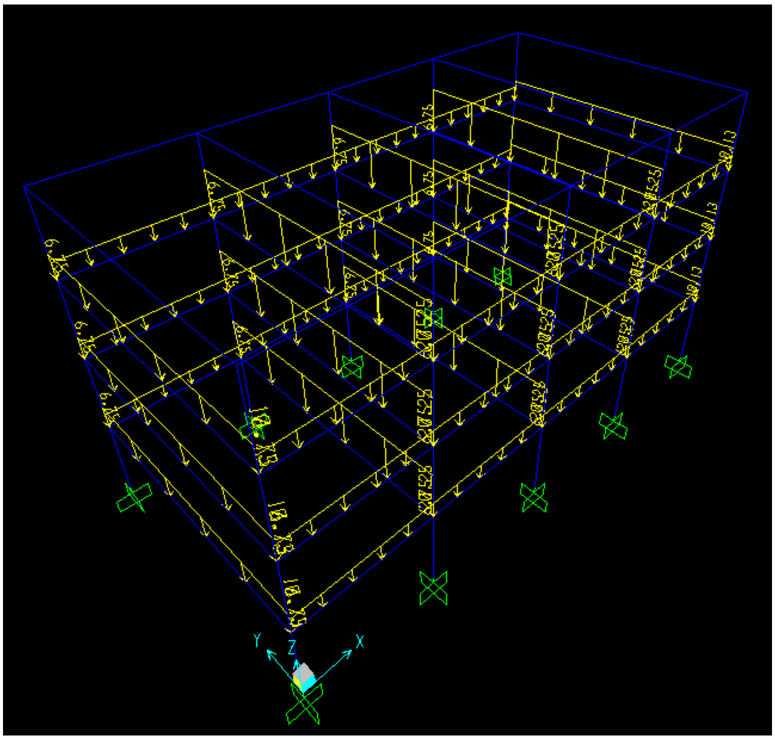
Earthquake load

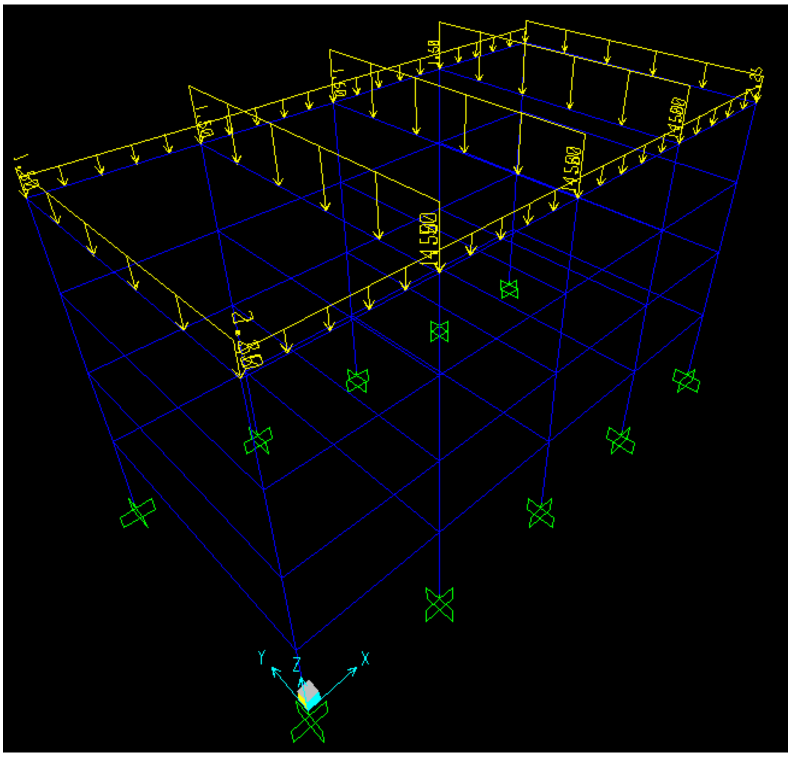
It was calculated with the software SAP 2000 and its Response spectrum mode, under data collected from Eurocode and the Iranian construction code.

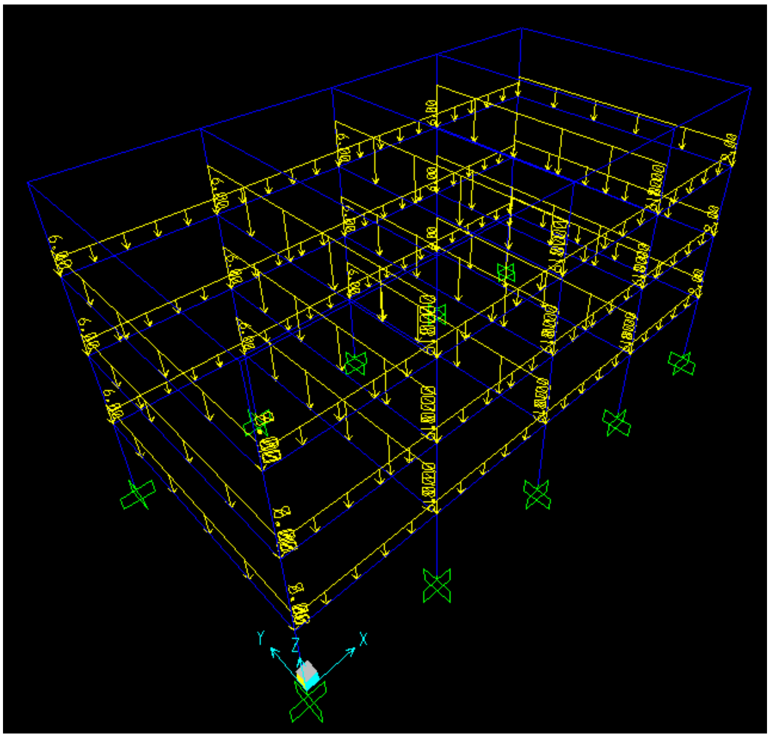


Computer aided structural analysis

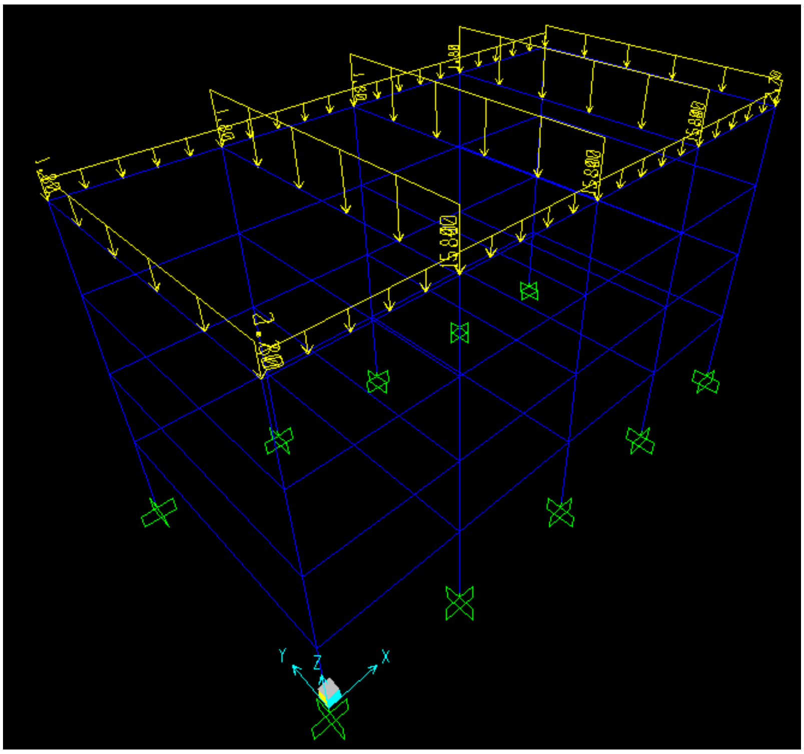
After the predesign, all the information was entered into SAP 2000, and run for a design check of the structure, obtaining the following:


Dead load due to the house units

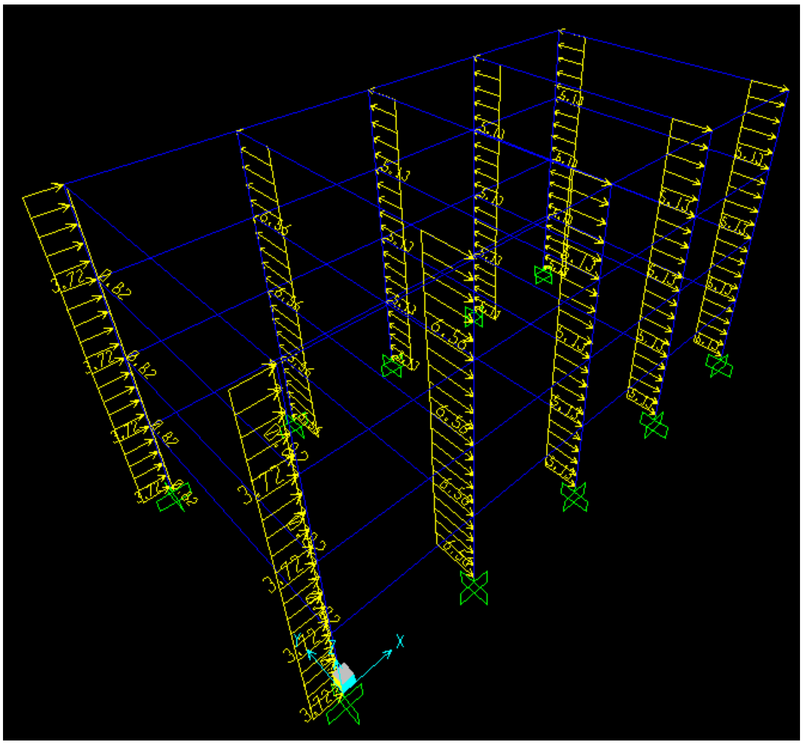

Live load on the roof

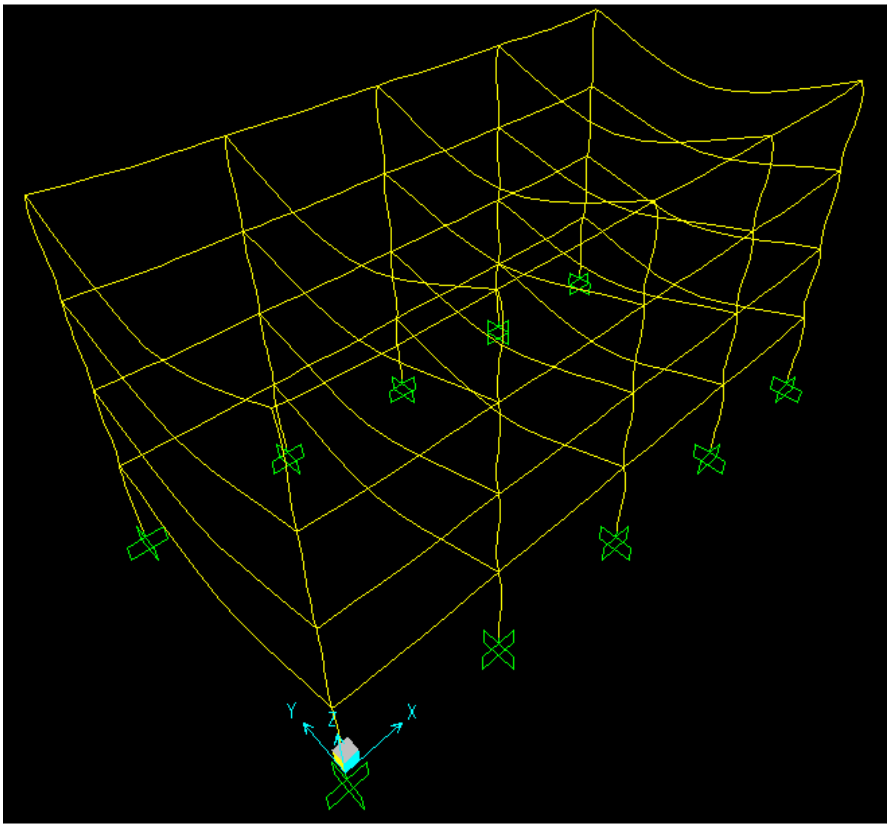


Live loads

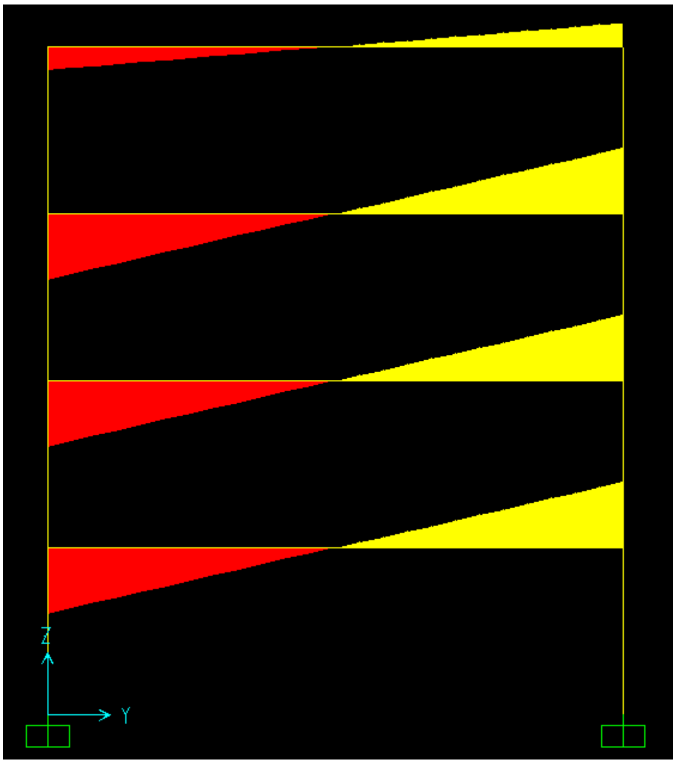


Snow load

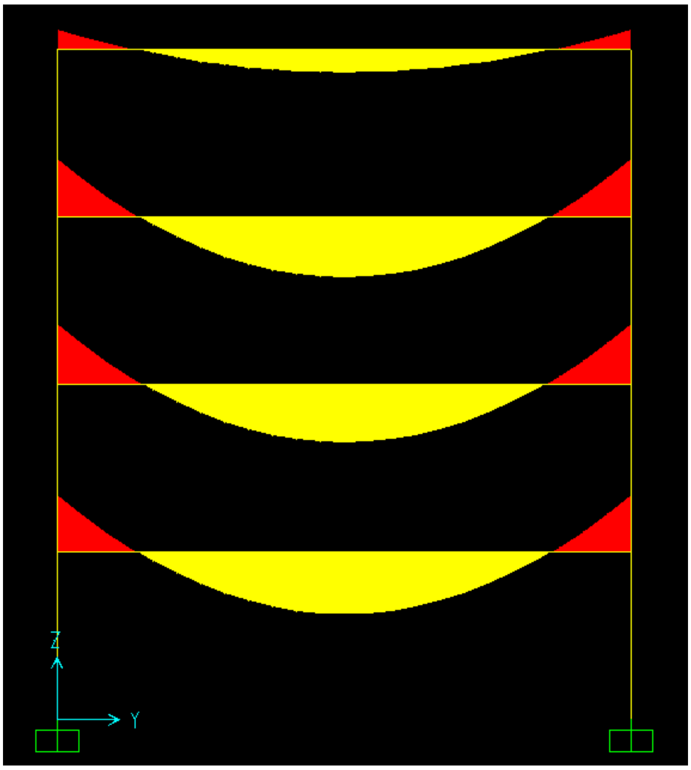

Wind loads



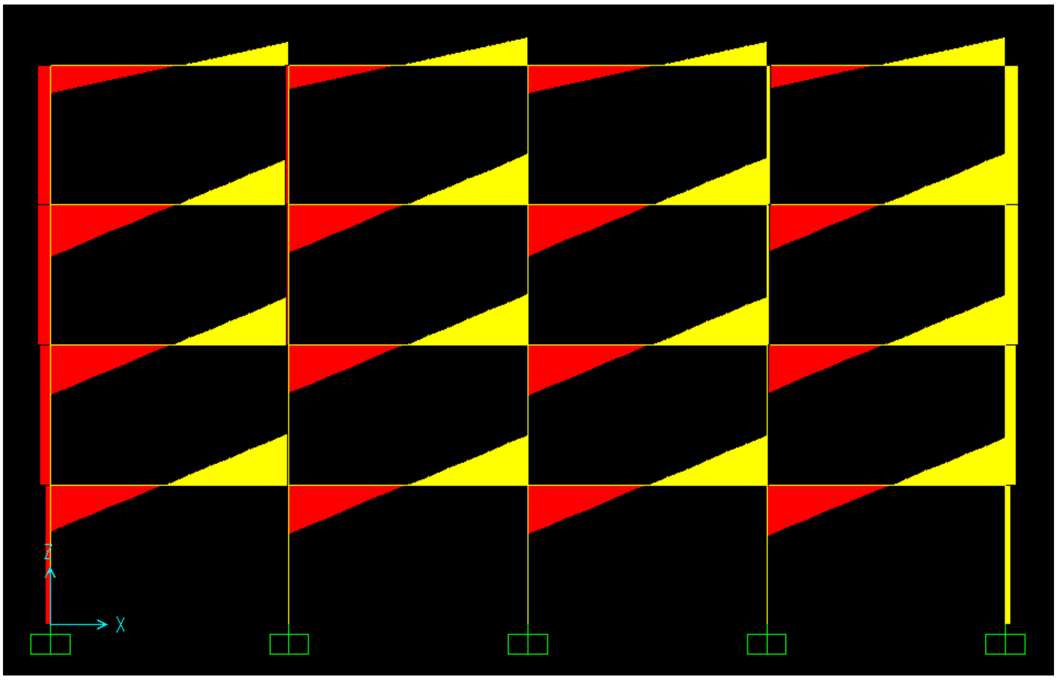
Deformed shape



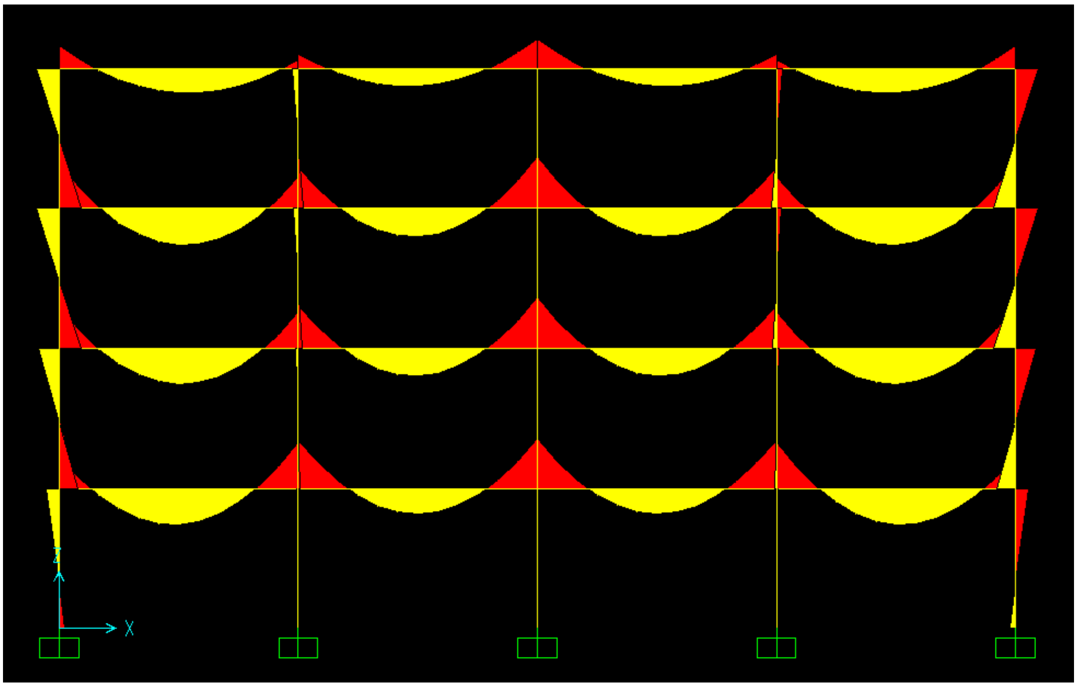
Shear diagram on the axis C



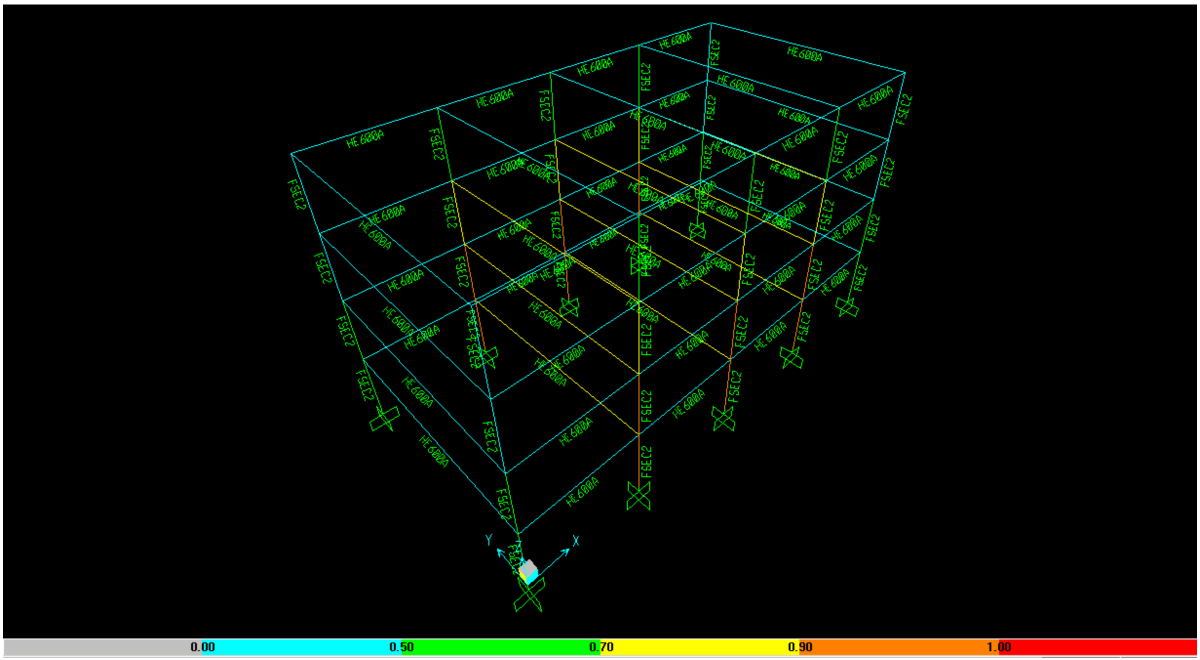
Moment diagram on the axis C



Moment diagram on the axis 1

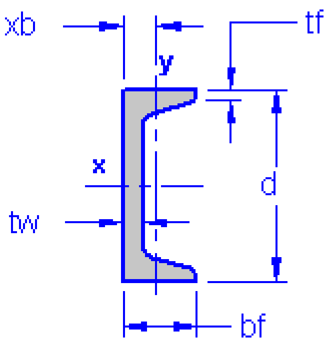


Moment diagram on the axis 1



Design check of the structure with all members passed under ultimate limit state.

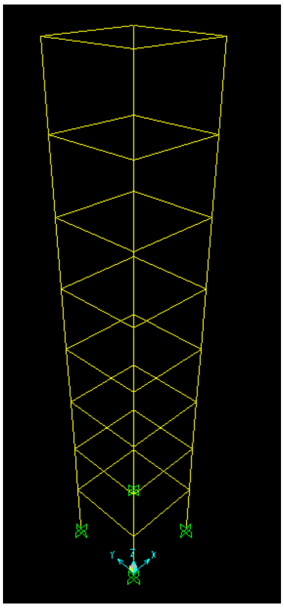
the secondary beams is a tube made out of two C15X50 channels, welded one in front of the other "steel section 2C15X50"



in x lb/ft	Area (in^2)	d (in)	bf (in)	tf (in)	tw (in)	Ixx (in^4)	Iyy (in^4)	xb (in)
C15x50	14.7	15	3.716	0.65	0.716	404	11	0.798

The cielings are hanging from them as well if neccesary.

For the wind catching column, which has a base of 5.5 m x 5.5 m, and 8 stories of 4 m for a total height of 24 m, it was followed the same procedure, obtaining:



Dead load 6.2 kN/m

$I \geq 5/384 * 200 * 6.2\ (5.5)^3 / 0.2_E{}^9 = 0.00001341 = \boxed{1.3_E{}^{-5}}$

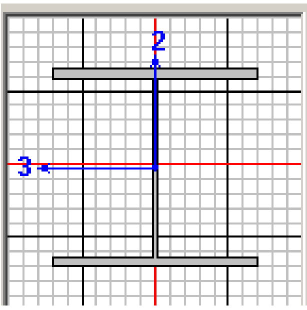
For the wind load we obtain a barely different table:

	length	height	area	Cpe	q(p)	We	F (Qk) kN	(qk) kN/m2	total length	kN/ml
A	1.100	24.000	26.400	-1.200	854.450	-1025.340	-27.069	-1.025	24.00	-1.13
B	4.400	24.000	105.600	-0.800	854.450	-683.560	-72.184	-0.684	24.00	-3.01
C	0.000									
D	5.500	24.000	114.000	0.800	854.450	683.560	77.926	0.684	48.00	1.62
E	5.500	24.000	114.000	-0.668	854.450	-570.773	-65.068	-0.571	48.00	-1.36

And then:

$I \geq 5/384 * 200 * 3.01\ (4)^3 / 0.2_E{}^9 = 0.0000025 = \boxed{2.5_E{}^{-6}}$

We choose the profile HE260A



Dimensions:

Outside height: 0.59

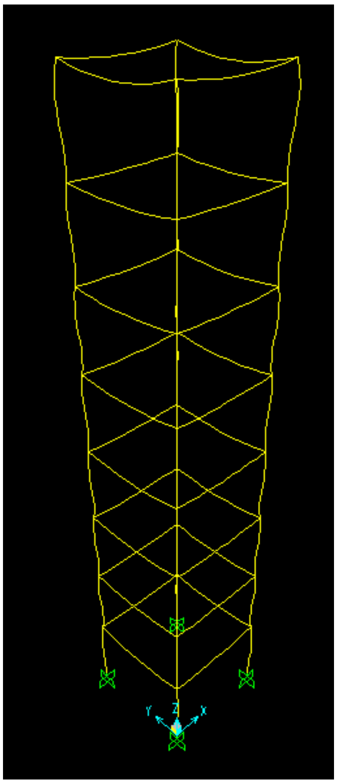
Top and bottom flange width: 0.3

Top and bottom flange thickness: 0.025

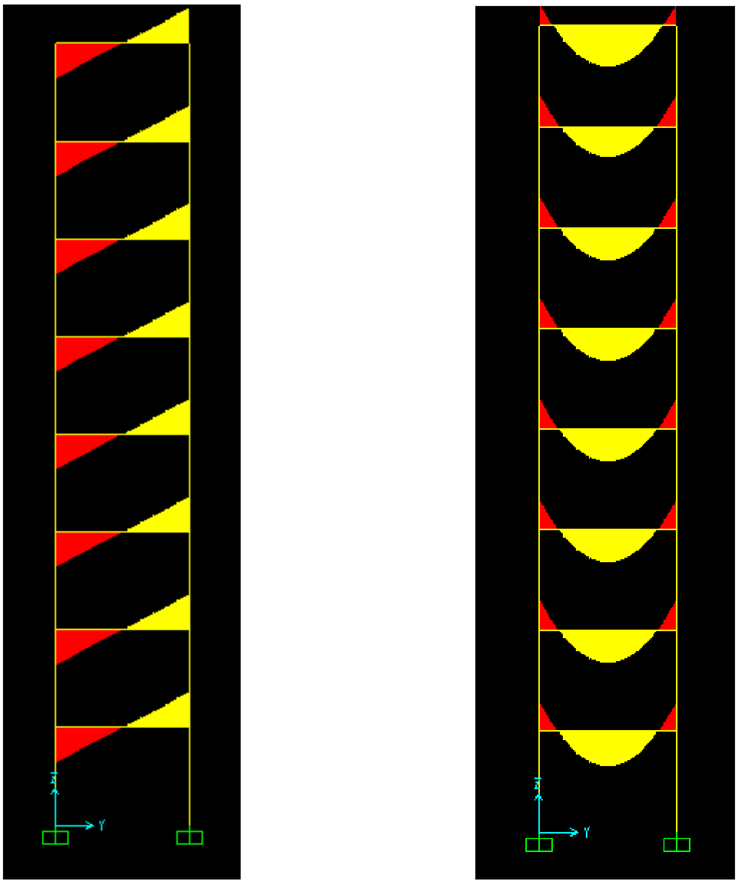
Web thickness: 0.013

$I=1.045_{E}^{-4}$ > 1.3_{E}^{-5}

> 2.5_{E}^{-6}



Deformed shape

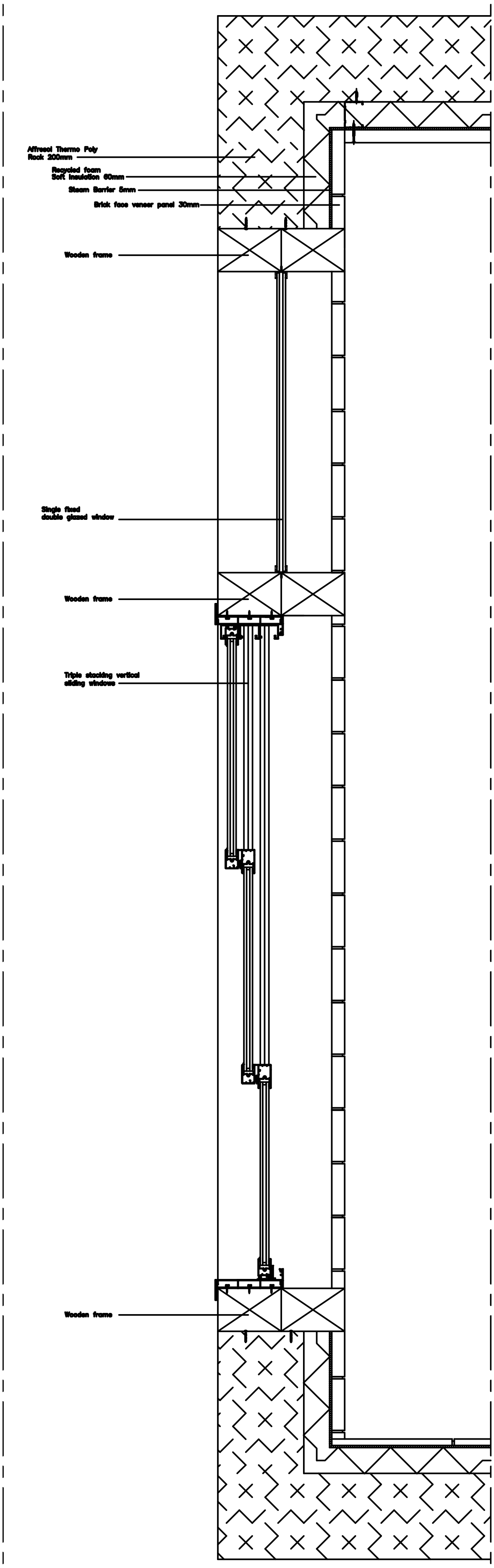


Shear and moment diagrams

Technological part:

Details of fixing between structure and house units, walls, slabs and windows.

Section View



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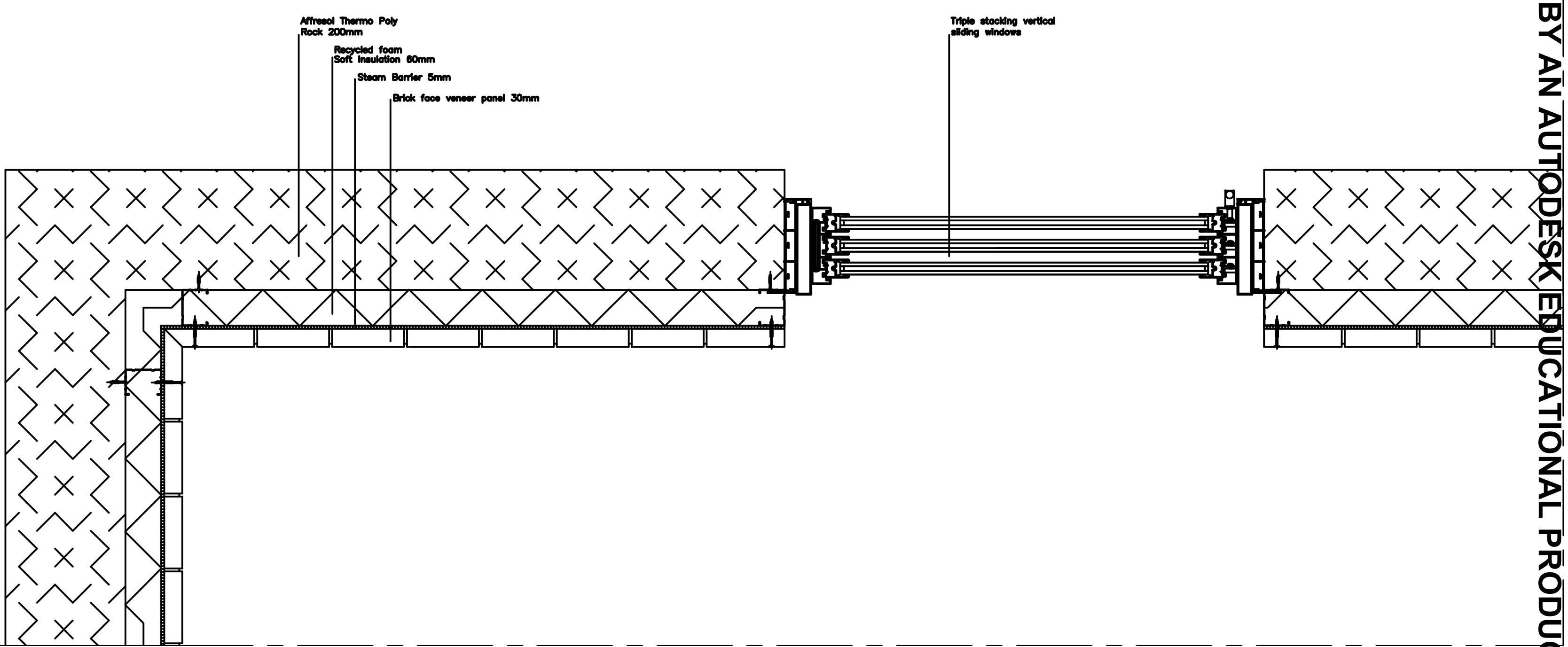
Plan View



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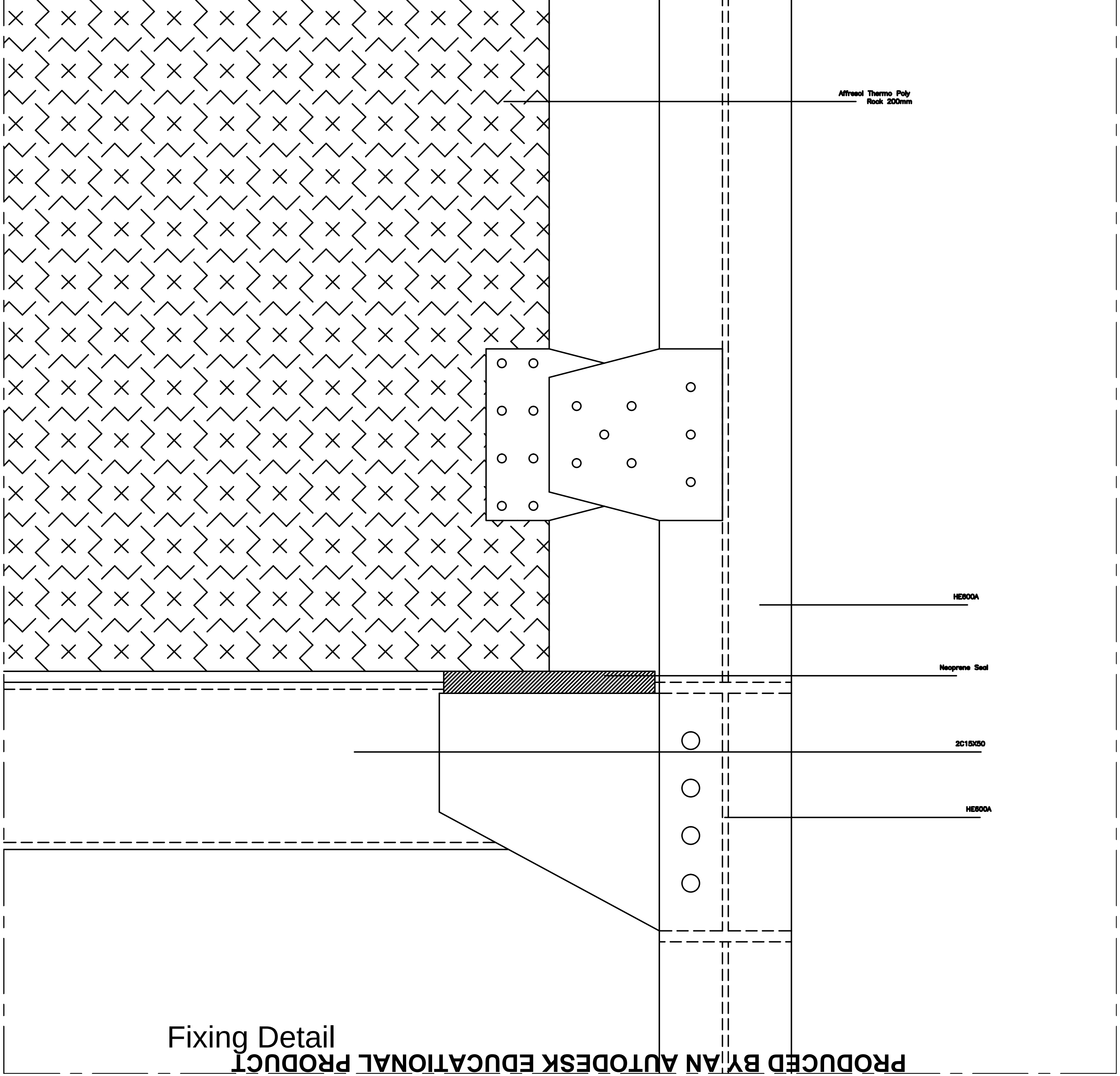
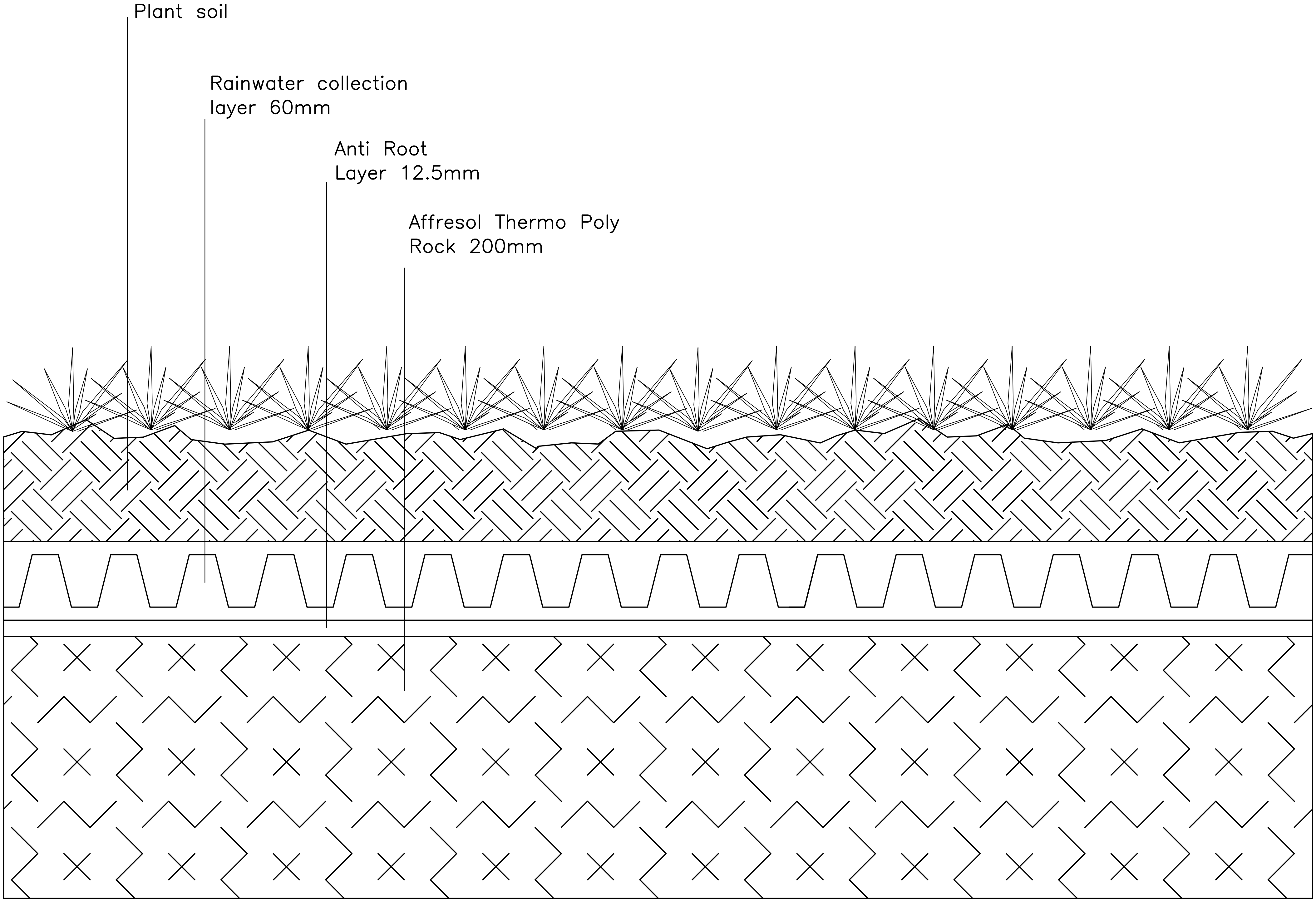
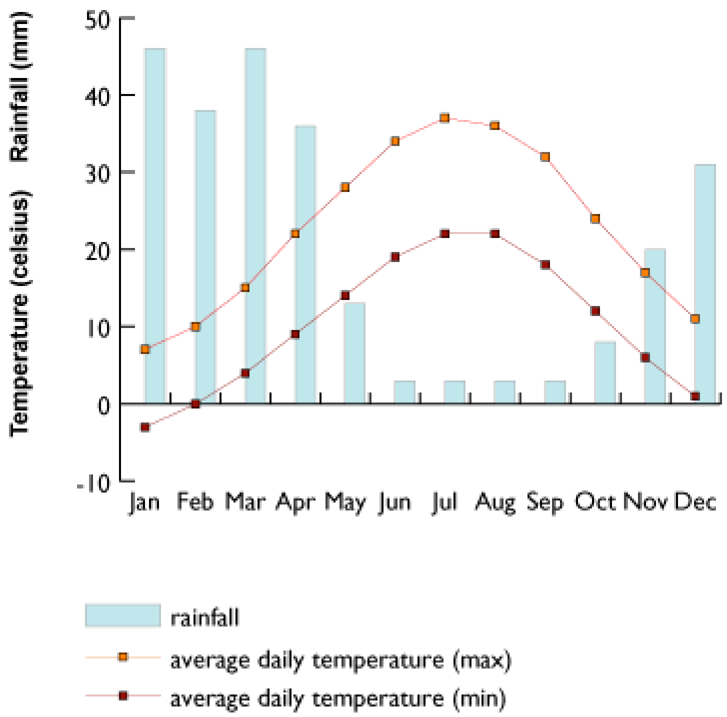


Fixing Detail


Plant soil
Rainwater collection layer 60mm
Anti Root Layer 12.5mm
Affresol Thermo Poly Rock 200mm

Tehran, Iran

Month	Average Sunlight (hours)	Temperature Average Min	Temperature Average Max	Temperature Record Min	Temperature Record Max	Discomfort from heat and humidity	Relative humidity am	Relative humidity pm	Average Precipitation (mm)	Wet Days (+0.25 mm)
Jan	6	-3	7	-21	18	-	77	75	46	4
Feb	7	0	10	-16	19	-	73	59	38	4
March	7	4	15	-9	29	-	61	39	46	5
April	7	9	22	-2	33	-	54	40	36	3
May	9	14	28	4	37	Medium	55	47	13	2
June	12	19	34	11	42	High	50	49	3	1
July	11	22	37	15	43	High	51	41	3	0.5
Aug	11	22	36	14	43	High	47	46	3	0.2
Sept	10	18	32	8	38	High	49	49	3	0.3
Oct	8	12	24	3	32	Moderate	53	54	8	1
Nov	7	6	17	-7	29	-	63	66	20	3
Dec	6	1	11	-12	20	-	76	75	31	4



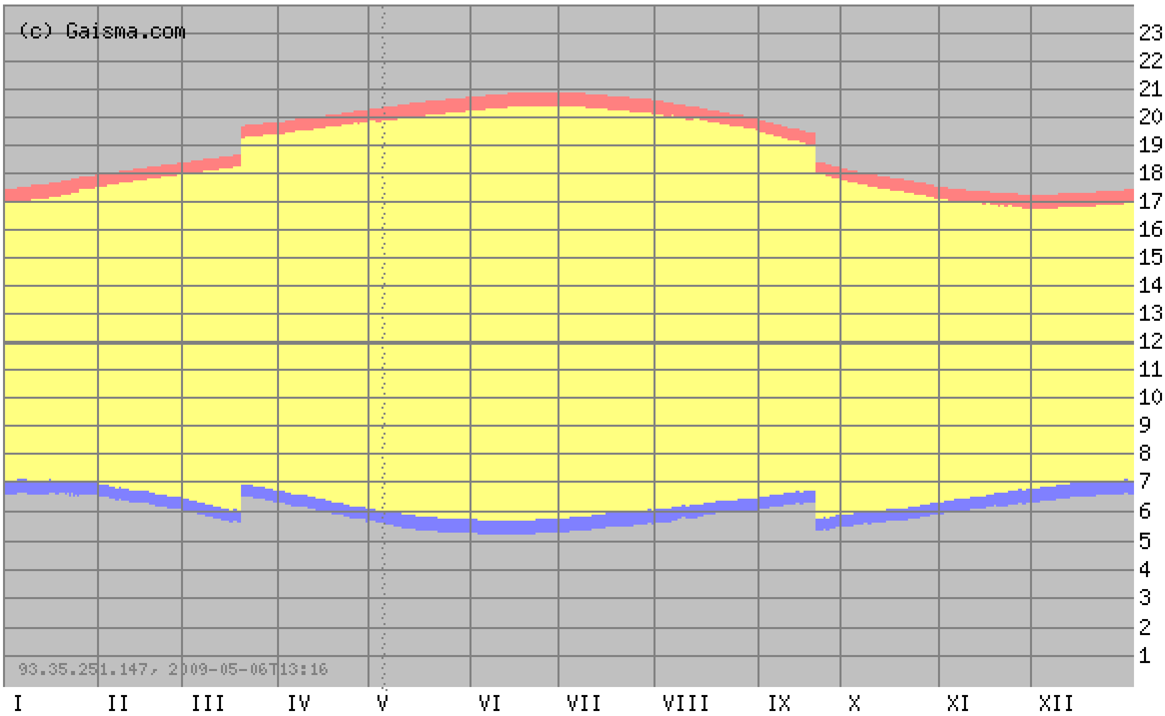
TEHRAN 35 68 N, 51 35 E, 3907 feet (1191 meters) above sea level.

Tehrān, Iran - Sunrise, sunset, dawn and dusk times, table

Date	Sunrise	Sunset	Length	Change	Dawn	Dusk	Length	Change
Today	*06:07*	*19:55*	13:48		*05:40*	*20:23*	14:43	
+1 day	*06:06*	*19:56*	13:50	00:02 longer	*05:39*	*20:24*	14:45	00:02 longer
+1 week	*06:01*	*20:01*	14:00	00:12 longer	*05:33*	*20:29*	14:56	00:13 longer
+2 weeks	*05:56*	*20:06*	14:10	00:22 longer	*05:27*	*20:35*	15:08	00:25 longer
+1 month	*05:49*	*20:17*	14:28	00:40 longer	*05:19*	*20:47*	15:28	00:45 longer
+2 months	*05:54*	*20:24*	14:30	00:42 longer	*05:24*	*20:53*	15:29	00:46 longer
+3 months	*06:15*	*20:06*	13:51	00:03 longer	*05:47*	*20:34*	14:47	00:04 longer
+6 months	06:29	17:06	10:37	03:11 shorter	06:02	17:33	11:31	03:12 shorter

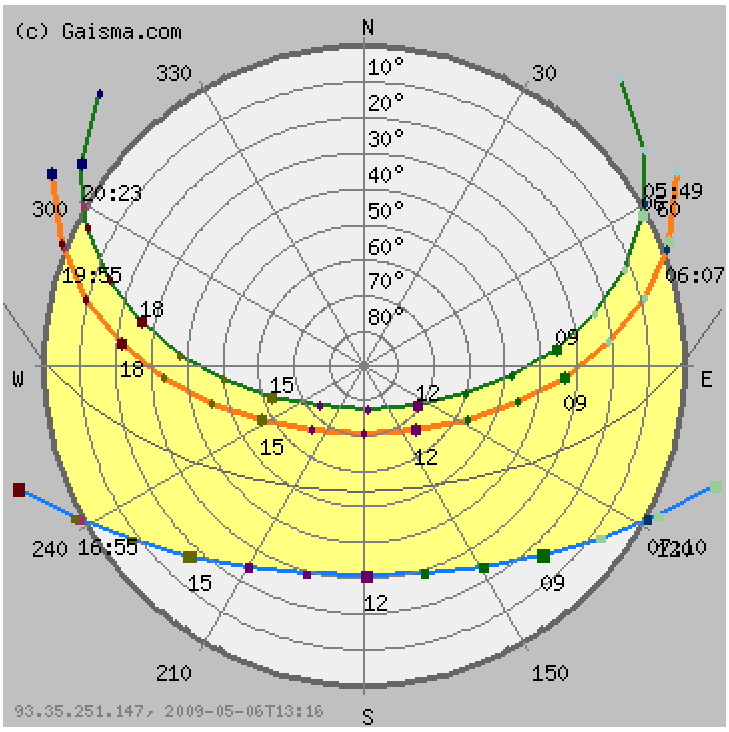
Notes: *Daylight saving time*, * = Next day. Change preferences.

Tehrān, Iran - Sunrise, sunset, dawn and dusk times, graph



Darkness Dawn Sunshine Dusk **Notes:** How to read this graph? Change preferences.

Tehrān, Iran - Sun path diagram



Sun path

Today

June 21

December 21

Annual variation

Equinox (March and September)

Sunrise/sunset

Sunrise

Sunset

Time

00-02

03-05

06-08

09-11

12-14

15-17

18-20

21-23

Notes: • = Daylight saving time, * = Next day. How to read this graph? Change preferences.

Tehrān, Iran - Solar energy and surface meteorology

Variable	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Insolation, kWh/m²/day	1.69	2.24	3.23	4.37	5.58	6.59	6.35	5.72	4.96	3.45	2.21	1.52
Clearness, 0 - 1	0.35	0.36	0.40	0.44	0.51	0.57	0.57	0.56	0.57	0.50	0.42	0.34
Temperature, °C	3.88	4.14	6.26	11.71	15.70	19.71	21.81	22.41	19.47	15.01	10.43	6.23

Wind speed, m/s	5.00	5.32	5.67	5.65	5.75	6.19	6.74	6.61	5.71	5.15	4.73	4.85
Precipitation, mm	37	34	40	33	22	6	4	4	2	16	22	36
Wet days, d	9.8	8.9	11.4	11.0	9.7	3.3	2.2	1.8	1.5	5.9	6.5	8.7

These data were obtained from the NASA Langley Research Center Atmospheric Science Data Center; New et al. 2002

Tehrān, Iran - Basic information

Latitude: +35.67 (35°40'12"N)

Longitude: +51.43 (51°25'48"E)

Time zone: UTC+3:30 hours

Local time: 17:46:20

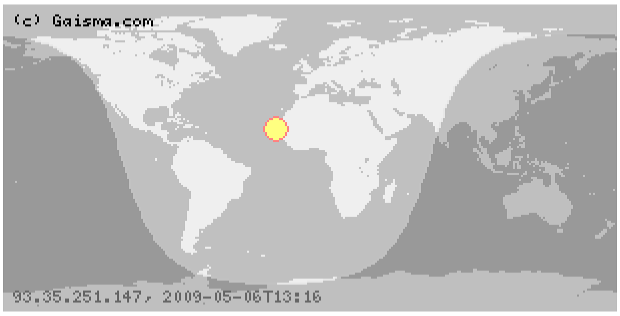
Country: Iran

Continent: Asia

Sub-region: Southern Asia

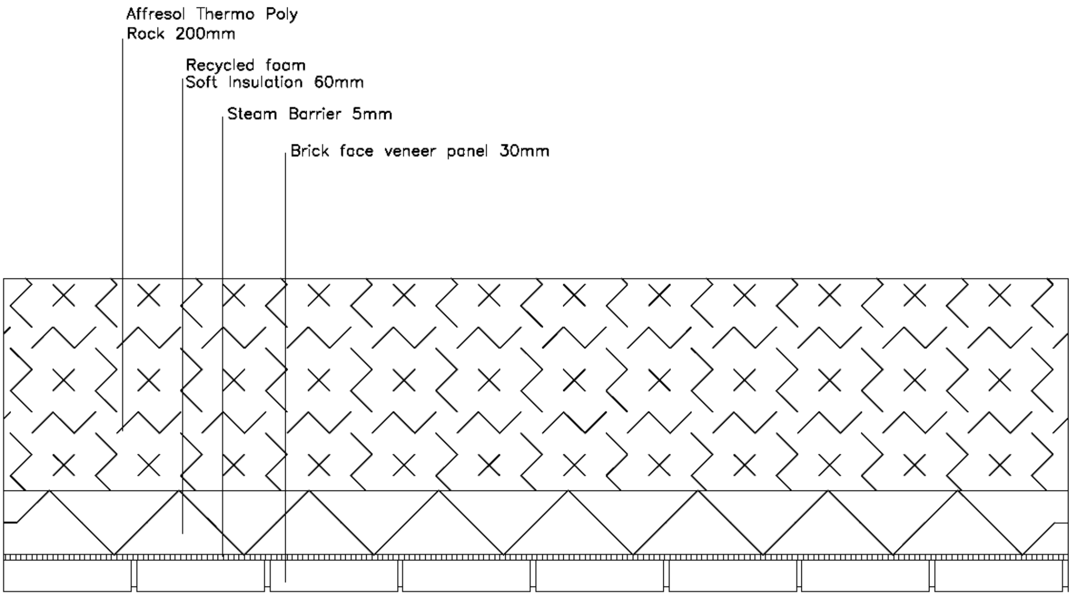
Distance: ~3400 km (from your IP)

Altitude: ~1100 m



U-Values

The walls are made of Affresol’s Thermo Poly Rock, which is a material made out of recycled waste. The insulation is recycled foam and it is added a vapor barrier and the internal finishing.



Layers:

No	Material	s	λ	s/λ	k=λ/s
		[m]	[W/mK]	[m²K/W]	[W/m²K]
1	Brick face veneer panel	0.025	0.17	0.147	6.80
2	Steam barrier	0.080	0.035	2.286	0.44
3	Recycled foam insulation	0.0600	0.03	2.000	0.50
4	Affresol Thermo Poly Rock	0.200	0.174	1.149	0.87
			Σ	5.582	

He = 25 W/m^{2}K
Hi = 7 W/m^{2}K

S= Σs= 0.365 [m]

R= 1/He+1/Hi+Σs/λ= 5.765 [m²K/W]

U=1/R= 0.173 W/m²K

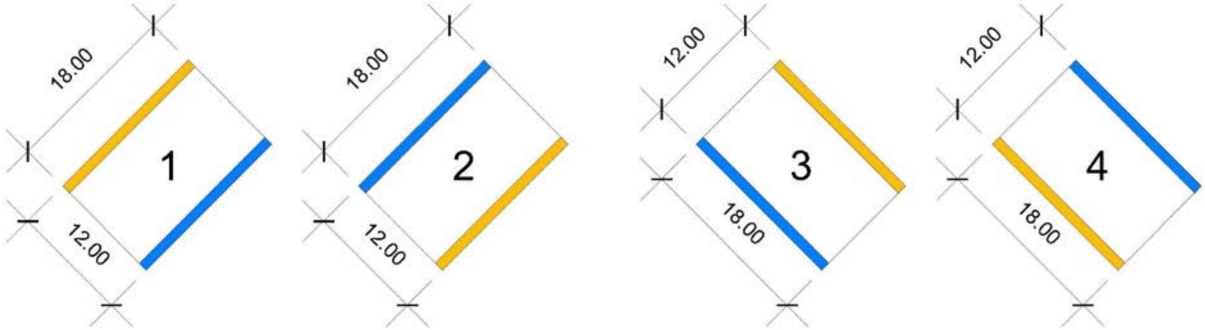
For the triple rack sliding windows, the U-value is obtained from the supplier:

U = 1.30 W/m^{2}K

Heating and cooling energy demands.

To obtain the thermal loads necessary to achieve thermal comfort inside each house, it was analyzed the 18 m x 12 m unit, which is the largest possible configuration, hence with the highest energy requirements, by entering it in the software CASAnova.

Since the project consists of four buildings, there are also 4 positions in which this unit can be found, and that will affect the thermal comfort needs.

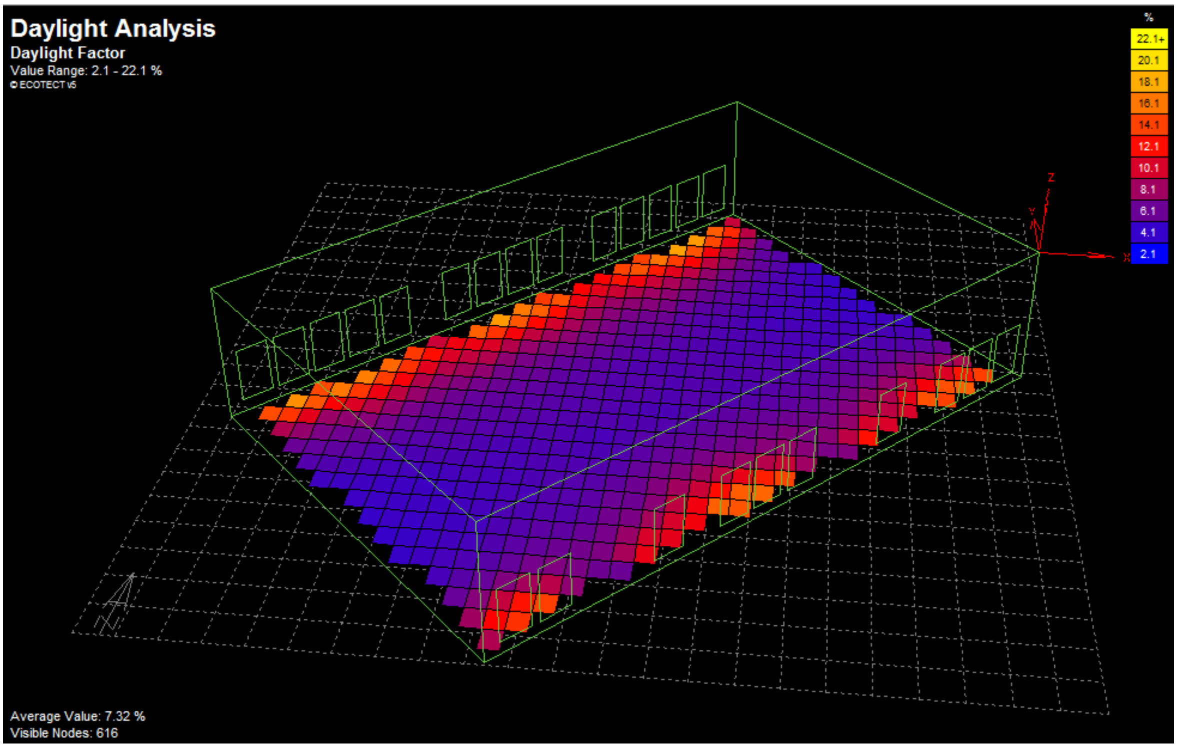


Where:

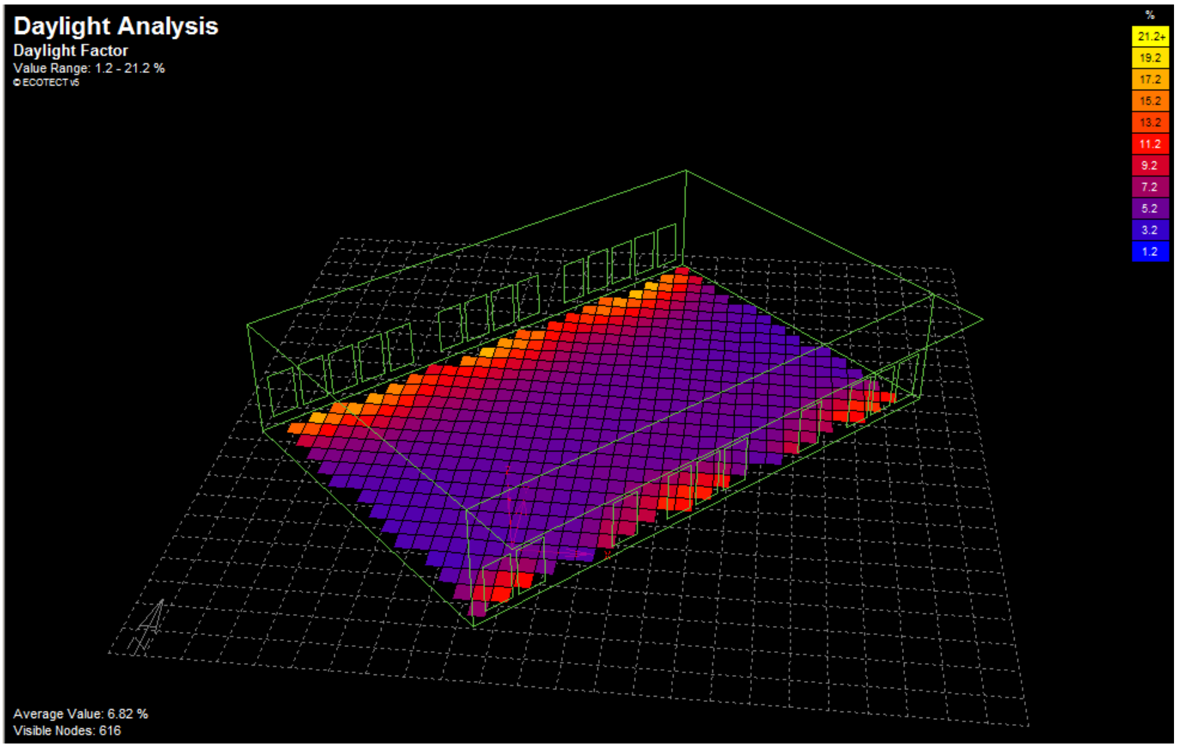
- 43% of the wall is window.
- 67% of the wall is window.

The general walking areas act as a shadow device at the front of each house unit, as well as the tinting of the windows on the back of them. To calculate the amount of shadow provided by these characteristics, a house unit was developed with the software Ecotect, and performed with it a daylight analysis without and with these shading options.

With transparent windows and not considering the effect of the upper slabs we get an average natural light level of 7.32%.



While applying this changes the average drops to 6.82%, which means approximately 7% of shading effect.



Finally, entering all the data, including this percentage as well as the 24% of framing of the windows on CASAnova, the heating and cooling loads needed where calculated.

Following are the reports obtained from the software for each of the positions, as well as the graphs for heating, zero and cooling energy hours throughout the year; and graphs for heating and cooling energy demands.

For the purpose of the CASAnova analysis, and because such software doesn't count with the climate data for Iran, it was chosen to use the city of Athens, Greece, due to its similarity to our study zone.

*CASA*nova **House type 1**

Data sheet

Geometry:

Length of north and south facade:	18.0 m
Length of west and east facade:	12.0 m
Height (without roof):	3.0 m
Number of floors:	1
Deviation from south direction (west positive):	-45.0 °
Ground area:	216.0 m²
Useful area:	172.8 m²
Volume total:	648.0 m³
Air volume:	518.4 m³
Facade north resp. south:	54.0 m²
Facade east resp. west:	36.0 m²
Surface-to-volume value:	0.9 1/m

Insulation:

U values of the walls:	
north:	0.17 W/(m² K)
south:	0.17 W/(m² K)
east:	0.17 W/(m² K)
west:	0.17 W/(m² K)
Absorption coefficient of the walls:	0.50
Upper floor:	
Towards:	outside or non-insulated roof
U value:	0.20 W/(m² K)
Lower floor:	
Towards:	non-heated cellar (with insulation)
U value:	0.20 W/(m² K)
Door (north facade):	
Area:	0.0 m²
U value:	1.50 W/(m² K)
Wärmebrücken:	increase U-values of surrounding planes by 0.10 W/(m² K) (normal construction)

Building:

Interior temperature:	20.0 °C
Limit of overheating:	27.0 °C
Ventilation:	
Natural ventilation (infiltration):	0.60 1/h
Mechanical ventilation:	0.00 1/h
Heat recovery (only mech. ventilation):	0 %
efficiency factor of air conditioning:	2.5 kWh_{cool} / kWh_{electr}
Internal gains:	25.0 kWh/(m² a)
Kind of indoor walls:	medium construction
Kind of outdoor walls:	medium construction

Climate:

Climate station:	Athinai (Hellas)

Windows:

North:

Windows area:	36.2 m²
Fraction of windows area at the facade:	67.0 %
Kind of windows:	others
U value glazing:	1.30 W/(m² K)
U value frame:	2.80 W/(m² K)
g value glazing:	0.80
Fraction of frame:	24.0 %
Shading:	7.0 %

South:

Window area:	23.2 m²
Fraction of windows area at the facade:	43.0 %
Kind of windows:	others
U value glazing:	1.30 W/(m² K)
U value frame:	2.80 W/(m² K)
g value glazing:	0.80
Fraction of frame:	24.0 %
Shading:	7.0 %

East:

Window area:	0.0 m²
Fraction of windows area at the facade:	0.0 %
Kind of windows:	others
U value glazing:	1.30 W/(m² K)
U value frame:	2.80 W/(m² K)
g value glazing:	0.80
Fraction of frame:	10.0 %
Shading:	50.0 %

West:

Window area:	0.0 m²
Fraction of windows area at the facade:	0.0 %
Kind of windows:	others
U value glazing:	1.30 W/(m² K)
U value frame:	2.80 W/(m² K)
g value glazing:	0.80
Fraction of frame:	10.0 %
Shading:	50.0 %

Energy:

Heating system:	low temperature burner, boiler and distribution inside the thermal zone
Heat transfer / system temperature:	radiators (outside walls), thermostatic valves (layout temperature: 1K), system temperature: 70/55°C
Source of energy:	fuel oil

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Output: Overview

Heat energy and cooling demand:

	Heat energy demand in kWh/m²	Cooling demand in kWh/m²
January	2.8	0.0
February	2.6	0.0
March	1.6	0.0
April	0.3	0.8
May	0.0	4.3
June	0.0	9.7
July	0.0	14.5
August	0.0	15.4
September	0.0	10.9
October	0.0	2.5
November	0.1	1.4
December	1.8	0.1
Yearly sum	9.3	59.6

Heating and cooling hours:

	Heating hours in hours	Zero energy hours in hours	Cooling hours in hours
January	508	236	0
February	538	134	0
March	489	255	0
April	217	414	89
May	0	299	445
June	0	96	624
July	0	0	744
August	0	0	744
September	0	96	624
October	0	371	373
November	300	215	205
December	531	203	10
Sum (in hours)	2583	2319	3858
Sum (in %)	29.5	26.5	44.0

*CASA*nova

Output: Climate and building data

Climate data:

	Mean temperature in °C	Maximum temperature in °C	Minimum temperature in °C
January	11.6	21.3	0.4
February	10.9	20.5	1.9
March	11.8	22.5	3.1
April	13.9	26.3	1.0
May	18.0	32.5	5.8
June	22.1	37.1	11.2
July	25.6	33.6	16.6
August	26.3	35.6	17.6
September	24.3	36.3	10.9
October	20.5	28.2	10.5
November	16.4	31.5	4.6
December	13.5	26.4	2.7
Yearly mean	18.0		

Building data:

Mean U value:	0.43 W/(m² K)
Specific transmission losses:	260.8 W/K
Specific ventilation losses:	111.5 W/K
Sum specific losses:	372.2 W/K
Thermal inertia:	45.7 hours
Maximum heating load:	6.7 kW
Maximum specific heating load:	39.0 W/m²
Maximum cooling load:	20.2 kW
Maximum specific cooling load:	116.9 W/m²
Limit temperature for heating:	18.5°C
Effective heating days:	196 Tage

*CASA*nova

Output: Heat balance

Specific (per m² useful area):

	Transm. losses in kWh/m²	Ventil. losses in kWh/m²	Internal Gains in kWh/m²	Solar Gains in kWh/m²	Usability factor	Heat energy demand in kWh/m²
January	8.2	4.0	1.7	7.8	0.81	2.8
February	8.1	3.9	1.5	7.8	0.81	2.6
March	8.1	3.9	1.5	8.8	0.71	1.6
April	5.8	2.8	0.9	7.4	0.46	0.3
May	2.0	1.0	0.3	2.6	0.14	0.0
June	0.0	0.0	0.0	0.0	0.00	0.0
July	0.0	0.0	0.0	0.0	0.00	0.0
August	0.0	0.0	0.0	0.0	0.00	0.0
September	0.0	0.0	0.0	0.0	0.00	0.0
October	0.0	0.0	0.0	0.0	0.00	0.0
November	3.5	1.7	0.9	4.1	0.44	0.1
December	6.4	3.1	1.7	6.0	0.78	1.8
Yearly sum	42.0	20.5	8.6	44.6		9.3

Absolute (total building):

	Transm. losses in kWh	Ventil. losses in kWh	Internal Gains in kWh	Solar Gains in kWh	Usability factor	Heat energy demand in kWh
January	1425	696	298	1343	0.81	479
February	1398	682	268	1355	0.81	458
March	1395	681	261	1529	0.71	285
April	1000	488	164	1278	0.46	46
May	339	165	51	453	0.14	0
June	0	0	0	0	0.00	0
July	0	0	0	0	0.00	0
August	0	0	0	0	0.00	0
September	0	0	0	0	0.00	0
October	0	0	0	0	0.00	0
November	597	291	156	709	0.44	23
December	1104	539	286	1043	0.78	314
Yearly sum	7258	3542	1484	7710		1606

*CASA*nova

Output: Cooling balance

Cooling demand and overheating:

	Cooling demand specific in kWh/m²	Cooling demand absolute in kWh	Mean overheating in hours/day	Cooling degree hours in Kh
January	0.0	0	0.0	0.0
February	0.0	0	0.0	0.0
March	0.0	0	0.0	0.0
April	0.8	139	3.0	124.8
May	4.3	746	14.4	1679.3
June	9.7	1675	20.8	3796.0
July	14.5	2498	24.0	6314.4
August	15.4	2657	24.0	7028.2
September	10.9	1889	20.8	5145.8
October	2.5	436	12.0	724.0
November	1.4	235	6.8	420.7
December	0.1	17	0.3	4.3
Yearly sum	59.6	10292		25237.5

*CASA*nova

Output: Primary and end energy demand for heating

Energy demand of the heating system:

Heat:

Heat energy demand:	9.3 kWh/(m² a)
Losses of the heat storage:	0.0 kWh/(m² a)
Heat losses from the distribution:	2.4 kWh/(m² a)
Looses at the transmission to the rooms:	1.1 kWh/(m² a)
Expense number of heat generation:	1.08
End energy demand fuel oil:	13.8 kWh/(m² a)
Primary energy factor fuel oil:	1.1
Primary energy demand fuel oil:	15.2 kWh/(m² a)

Auxiliary energy (electricity):

Auxiliary energy for heat generation:	0.6 kWh/(m² a)
Auxiliary energy for heat storage:	0.0 kWh/(m² a)
Auxiliary energy for heat distribution:	1.1 kWh/(m² a)
End energy demand auxiliary energy (electricity):	1.7 kWh/(m² a)
Primary energy factor electricity:	3.0
Primary energy demand auxiliary energy (electricity):	5.2 kWh/(m² a)

	End energy demand fuel oil in kWh/m²	End energy demand electricity in kWh/m²	End energy demand total in kWh/m²	Primary demand fuel oil in kWh/m²	Primary demand electricity in kWh/m²	Primary demand total in kWh/m²
January	4.1	0.5	4.6	4.5	1.6	6.1
February	3.9	0.5	4.4	4.3	1.5	5.8
March	2.5	0.3	2.8	2.7	0.9	3.6
April	0.4	0.0	0.4	0.4	0.1	0.6
May	0.0	0.0	0.0	0.0	0.0	0.0
June	0.0	0.0	0.0	0.0	0.0	0.0
July	0.0	0.0	0.0	0.0	0.0	0.0
August	0.0	0.0	0.0	0.0	0.0	0.0
September	0.0	0.0	0.0	0.0	0.0	0.0
October	0.0	0.0	0.0	0.0	0.0	0.0
November	0.2	0.0	0.2	0.2	0.1	0.3
December	2.7	0.3	3.0	3.0	1.0	4.0
Yearly sum	13.8	1.7	15.6	15.2	5.2	20.4

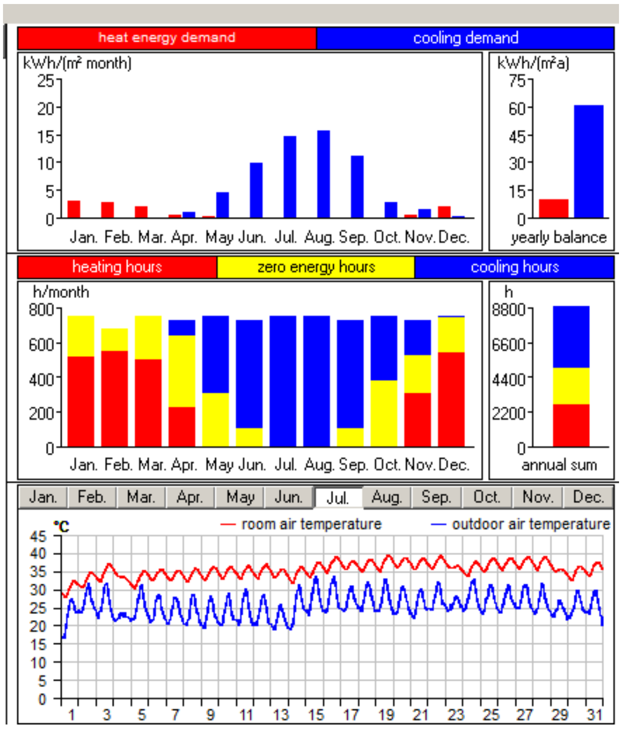
CASAnova

Output: Primary and end energy demand for cooling

<u>Energy demand of the cooling system:</u>

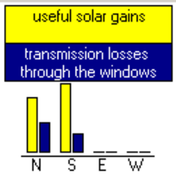
Efficiency factor of the air conditioning: 2.5 kWh cooling/ kWh electricity

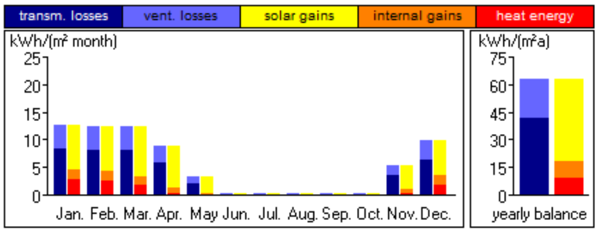
	Cooling demand in kWh/m²	End energy demand for cooling in kWh/m²	Primary energy demand in kWh/m²
January	0.0	0.0	0.0
February	0.0	0.0	0.0
March	0.0	0.0	0.0
April	0.8	0.3	1.0
May	4.3	1.7	5.2
June	9.7	3.9	11.6
July	14.5	5.8	17.3
August	15.4	6.1	18.4
September	10.9	4.4	13.1
October	2.5	1.0	3.0
November	1.4	0.5	1.6
December	0.1	0.0	0.1
Yearly sum	59.6	23.8	71.5

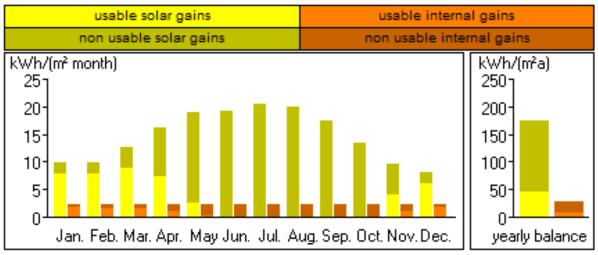


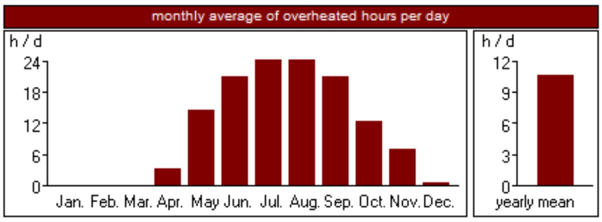
yearly balance:

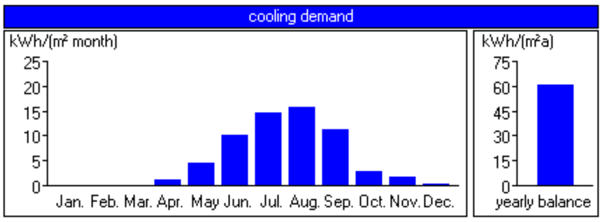
	absolute in kWh/a	specific in kWh/(m² a)
transmission losses:	7258	42.0
ventilation losses:	3542	20.5
usable solar gains:	7710	44.6
usable internal gains:	1484	8.6
heat energy demand:	1606	9.3

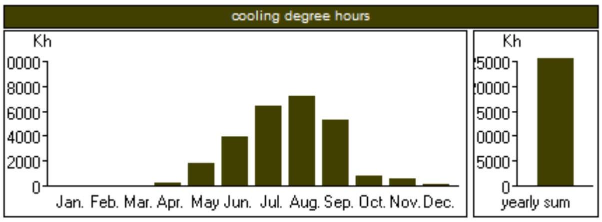












*CASA*nova <u>House type 2</u>

Data sheet

Geometry:

Length of north and south facade:	18.0 m
Length of west and east facade:	12.0 m
Height (without roof):	3.0 m
Number of floors:	1
Deviation from south direction (west positive):	-45.0 °
Ground area:	216.0 m²
Useful area:	172.8 m²
Volume total:	648.0 m³
Air volume:	518.4 m³
Facade north resp. south:	54.0 m²
Facade east resp. west:	36.0 m²
Surface-to-volume value:	0.9 1/m

Insulation:

U values of the walls:	
north:	0.17 W/(m² K)
south:	0.17 W/(m² K)
east:	0.17 W/(m² K)
west:	0.17 W/(m² K)
Absorption coefficient of the walls:	0.50
Upper floor:	
Towards:	outside or non-insulated roof
U value:	0.20 W/(m² K)
Lower floor:	
Towards:	non-heated cellar (with insulation)
U value:	0.20 W/(m² K)
Door (north facade):	
Area:	0.0 m²
U value:	1.50 W/(m² K)
Wärmebrücken:	increase U-values of surrounding planes by 0.10 W/(m² K) (normal construction)

Building:

Interior temperature:	20.0 °C
Limit of overheating:	27.0 °C
Ventilation:	
Natural ventilation (infiltration):	0.60 1/h
Mechanical ventilation:	0.00 1/h
Heat recovery (only mech. ventilation):	0 %
efficiency factor of air conditioning:	2.5 kWh_{cool} / kWh_{electr}
Internal gains:	25.0 kWh/(m² a)
Kind of indoor walls:	medium construction
Kind of outdoor walls:	medium construction

Climate:

Climate station:	Athinai (Hellas)

Windows:

North:	
Windows area:	23.2 m²
Fraction of windows area at the facade:	43.0 %
Kind of windows:	others
U value glazing:	1.30 W/(m² K)
U value frame:	2.80 W/(m² K)
g value glazing:	0.80
Fraction of frame:	24.0 %
Shading:	7.0 %
South:	
Window area:	36.2 m²
Fraction of windows area at the facade:	67.0 %
Kind of windows:	others
U value glazing:	1.30 W/(m² K)
U value frame:	2.80 W/(m² K)
g value glazing:	0.80
Fraction of frame:	24.0 %
Shading:	7.0 %
East:	
Window area:	0.0 m²
Fraction of windows area at the facade:	0.0 %
Kind of windows:	others
U value glazing:	1.30 W/(m² K)
U value frame:	2.80 W/(m² K)
g value glazing:	0.80
Fraction of frame:	10.0 %
Shading:	50.0 %
West:	
Window area:	0.0 m²
Fraction of windows area at the facade:	0.0 %
Kind of windows:	others
U value glazing:	1.30 W/(m² K)
U value frame:	2.80 W/(m² K)
g value glazing:	0.80
Fraction of frame:	10.0 %
Shading:	50.0 %

Energy:

Heating system:	low temperature burner, boiler and distribution inside the thermal zone
Heat transfer / system temperature:	radiators (outside walls), thermostatic valves (layout temperature: 1K), system temperature: 70/55°C
Source of energy:	fuel oil

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Output: Overview

Heat energy and cooling demand:

	Heat energy demand in kWh/m²	Cooling demand in kWh/m²
January	2.0	0.0
February	2.1	0.0
March	1.4	0.1
April	0.2	1.3
May	0.0	5.0
June	0.0	10.4
July	0.0	15.7
August	0.0	17.5
September	0.0	13.7
October	0.0	4.7
November	0.1	2.0
December	1.3	0.4
Yearly sum	7.0	70.9

Heating and cooling hours:

	Heating hours in hours	Zero energy hours in hours	Cooling hours in hours
January	386	358	0
February	449	223	0
March	418	310	16
April	142	449	129
May	0	270	474
June	0	78	642
July	0	0	744
August	0	0	744
September	0	29	691
October	0	180	564
November	289	170	261
December	477	228	39
Sum (in hours)	2161	2295	4304
Sum (in %)	24.7	26.2	49.1

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Output: Climate and building data

Climate data:

	Mean temperature in °C	Maximum temperature in °C	Minimum temperature in °C
January	11.6	21.3	0.4
February	10.9	20.5	1.9
March	11.8	22.5	3.1
April	13.9	26.3	1.0
May	18.0	32.5	5.8
June	22.1	37.1	11.2
July	25.6	33.6	16.6
August	26.3	35.6	17.6
September	24.3	36.3	10.9
October	20.5	28.2	10.5
November	16.4	31.5	4.6
December	13.5	26.4	2.7
Yearly mean	18.0		

Building data:

Mean U value:	0.43 W/(m² K)
Specific transmission losses:	260.8 W/K
Specific ventilation losses:	111.5 W/K
Sum specific losses:	372.2 W/K
Thermal inertia:	45.7 hours
Maximum heating load:	6.7 kW
Maximum specific heating load:	39.0 W/m²
Maximum cooling load:	27.6 kW
Maximum specific cooling load:	159.4 W/m²
Limit temperature for heating:	18.5°C
Effective heating days:	196 Tage

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Output: Heat balance

Specific (per m² useful area):

	Transm. losses in kWh/m²	Ventil. losses in kWh/m²	Internal Gains in kWh/m²	Solar Gains in kWh/m²	Usability factor	Heat energy demand in kWh/m²
January	8.2	4.0	1.6	8.7	0.75	2.0
February	8.1	3.9	1.4	8.5	0.76	2.1
March	8.1	3.9	1.4	9.2	0.67	1.4
April	5.8	2.8	0.9	7.5	0.43	0.2
May	2.0	1.0	0.3	2.6	0.13	0.0
June	0.0	0.0	0.0	0.0	0.00	0.0
July	0.0	0.0	0.0	0.0	0.00	0.0
August	0.0	0.0	0.0	0.0	0.00	0.0
September	0.0	0.0	0.0	0.0	0.00	0.0
October	0.0	0.0	0.0	0.0	0.00	0.0
November	3.5	1.7	0.8	4.3	0.38	0.1
December	6.4	3.1	1.5	6.7	0.71	1.3
Yearly sum	42.0	20.5	7.9	47.5		7.0

Absolute (total building):

	Transm. losses in kWh	Ventil. losses in kWh	Internal Gains in kWh	Solar Gains in kWh	Usability factor	Heat energy demand in kWh
January	1425	696	275	1495	0.75	351
February	1398	682	250	1475	0.76	355
March	1395	681	247	1594	0.67	234
April	1000	488	152	1301	0.43	35
May	339	165	49	456	0.13	0
June	0	0	0	0	0.00	0
July	0	0	0	0	0.00	0
August	0	0	0	0	0.00	0
September	0	0	0	0	0.00	0
October	0	0	0	0	0.00	0
November	597	291	136	738	0.38	14
December	1104	539	262	1154	0.71	227
Yearly sum	7258	3542	1370	8213		1217

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Output: Cooling balance

Cooling demand and overheating:

	Cooling demand specific in kWh/m²	Cooling demand absolute in kWh	Mean overheating in hours/day	Cooling degree hours in Kh
January	0.0	0	0.0	0.0
February	0.0	0	0.0	0.0
March	0.1	22	0.5	8.9
April	1.3	219	4.3	266.7
May	5.0	869	15.3	1998.6
June	10.4	1800	21.4	4136.0
July	15.7	2706	24.0	6863.6
August	17.5	3032	24.0	8036.7
September	13.7	2364	23.0	6378.7
October	4.7	809	18.2	1533.5
November	2.0	353	8.7	720.2
December	0.4	76	1.3	56.7
Yearly sum	70.9	12251		29999.6

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Output: Primary and end energy demand for heating

Energy demand of the heating system:

Heat:

Heat energy demand:	7.0 kWh/(m² a)
Losses of the heat storage:	0.0 kWh/(m² a)
Heat losses from the distribution:	2.4 kWh/(m² a)
Looses at the transmission to the rooms:	1.1 kWh/(m² a)
Expense number of heat generation:	1.08
End energy demand fuel oil:	11.4 kWh/(m² a)
Primary energy factor fuel oil:	1.1
Primary energy demand fuel oil:	12.5 kWh/(m² a)

Auxiliary energy (electricity):

Auxiliary energy for heat generation:	0.6 kWh/(m² a)
Auxiliary energy for heat storage:	0.0 kWh/(m² a)
Auxiliary energy for heat distribution:	1.1 kWh/(m² a)
End energy demand auxiliary energy (electricity):	1.7 kWh/(m² a)
Primary energy factor electricity:	3.0
Primary energy demand auxiliary energy (electricity):	5.2 kWh/(m² a)

	End energy demand fuel oil in kWh/m²	End energy demand electricity in kWh/m²	End energy demand total in kWh/m²	Primary demand fuel oil in kWh/m²	Primary demand electricity in kWh/m²	Primary demand total in kWh/m²
January	3.3	0.5	3.8	3.6	1.5	5.1
February	3.3	0.5	3.8	3.7	1.5	5.2
March	2.2	0.3	2.5	2.4	1.0	3.4
April	0.3	0.0	0.4	0.4	0.1	0.5
May	0.0	0.0	0.0	0.0	0.0	0.0
June	0.0	0.0	0.0	0.0	0.0	0.0
July	0.0	0.0	0.0	0.0	0.0	0.0
August	0.0	0.0	0.0	0.0	0.0	0.0
September	0.0	0.0	0.0	0.0	0.0	0.0
October	0.0	0.0	0.0	0.0	0.0	0.0
November	0.1	0.0	0.2	0.1	0.1	0.2
December	2.1	0.3	2.4	2.3	1.0	3.3
Yearly sum	11.4	1.7	13.1	12.5	5.2	17.7

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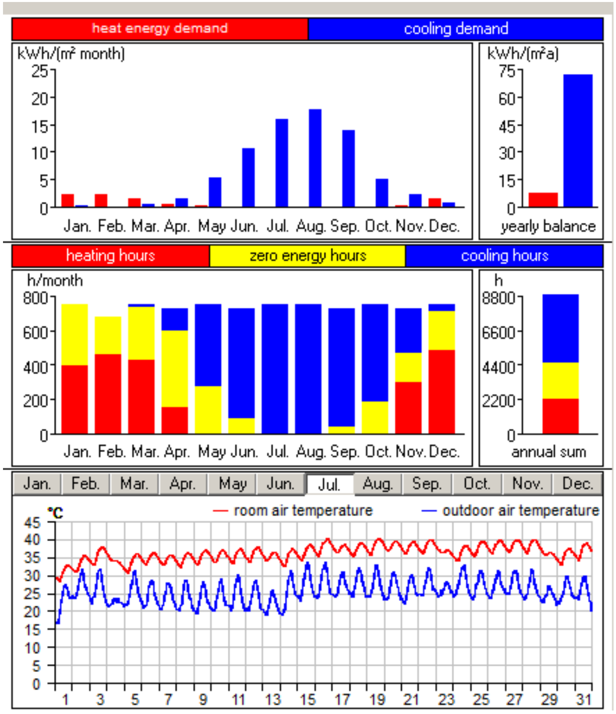
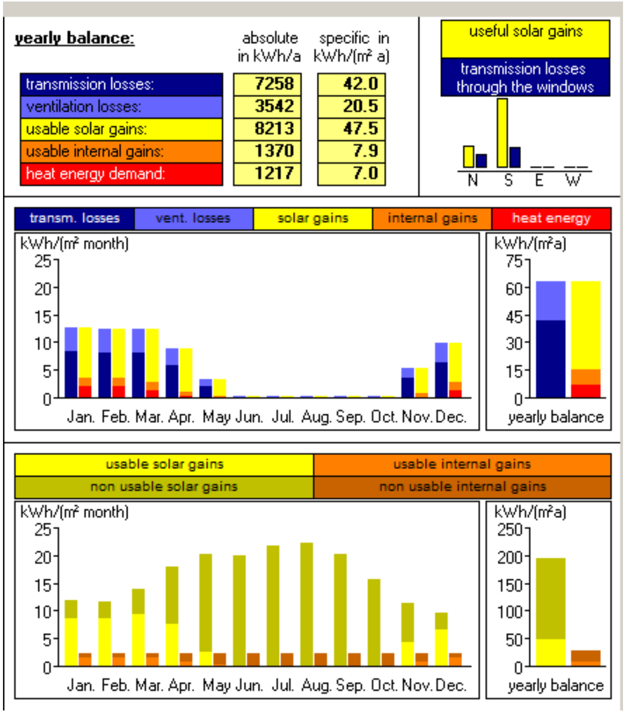
Output: Primary and end energy demand for cooling

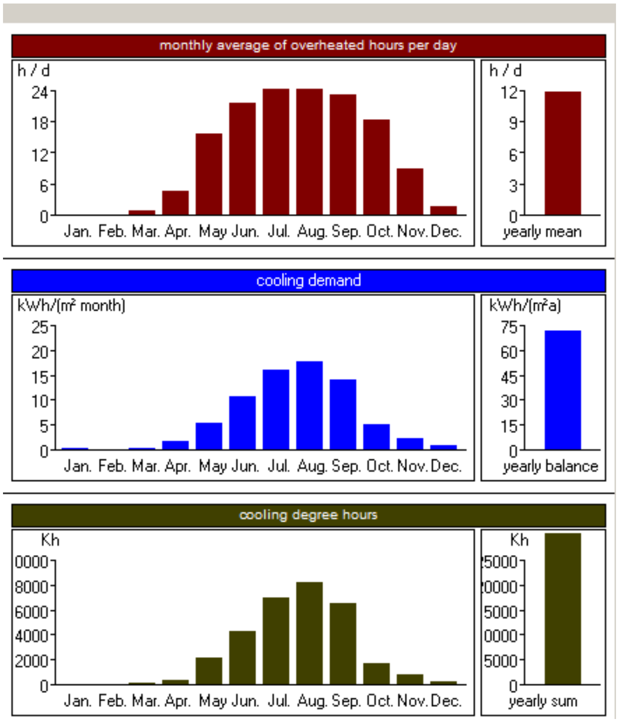
Energy demand of the cooling system:

Efficiency factor of the air conditioning: 2.5 kWh cooling/ kWh electricity

	Cooling demand in kWh/m²	End energy demand for cooling in kWh/m²	Primary energy demand in kWh/m²
January	0.0	0.0	0.0
February	0.0	0.0	0.0
March	0.1	0.1	0.2
April	1.3	0.5	1.5
May	5.0	2.0	6.0
June	10.4	4.2	12.5
July	15.7	6.3	18.8
August	17.5	7.0	21.1
September	13.7	5.5	16.4
October	4.7	1.9	5.6
November	2.0	0.8	2.5
December	0.4	0.2	0.5
Yearly sum	70.9	28.4	85.1




yearly balance:
absolute in kWh/a
specific in kWh/(m² a)
transmission losses: 7258 42.0
ventilation losses: 3542 20.5
usable solar gains: 8213 47.5
usable internal gains: 1370 7.9
heat energy demand: 1217 7.0
useful solar gains
transmission losses through the windows
N S E W
transm. losses
vent. losses
solar gains
internal gains
heat energy
kWh/(m² month)
kWh/(m²a)
Jan. Feb. Mar. Apr. May Jun. Jul. Aug. Sep. Oct. Nov. Dec.
yearly balance
usable solar gains
usable internal gains
non usable solar gains
non usable internal gains
kWh/(m² month)
kWh/(m²a)
Jan. Feb. Mar. Apr. May Jun. Jul. Aug. Sep. Oct. Nov. Dec.
yearly balance


monthly average of overheated hours per day
h / d
Jan. Feb. Mar. Apr. May Jun. Jul. Aug. Sep. Oct. Nov. Dec.
yearly mean
cooling demand
kWh/(m² month)
kWh/(m²a)
Jan. Feb. Mar. Apr. May Jun. Jul. Aug. Sep. Oct. Nov. Dec.
yearly balance
cooling degree hours
Kh
Jan. Feb. Mar. Apr. May Jun. Jul. Aug. Sep. Oct. Nov. Dec.
yearly sum

*CASA*nova House type 3

Data sheet

Geometry:

Length of north and south facade:	12.0 m
Length of west and east facade:	18.0 m
Height (without roof):	3.0 m
Number of floors:	1
Deviation from south direction (west positive):	-45.0 °
Ground area:	216.0 m²
Useful area:	172.8 m²
Volume total:	648.0 m³
Air volume:	518.4 m³
Facade north resp. south:	36.0 m²
Facade east resp. west:	54.0 m²
Surface-to-volume value:	0.9 1/m

Insulation:

U values of the walls:	
north:	0.17 W/(m² K)
south:	0.17 W/(m² K)
east:	0.17 W/(m² K)
west:	0.17 W/(m² K)
Absorption coefficient of the walls:	0.50
Upper floor:	
Towards:	outside or non-insulated roof
U value:	0.20 W/(m² K)
Lower floor:	
Towards:	non-heated cellar (with insulation)
U value:	0.20 W/(m² K)
Door (north facade):	
Area:	0.0 m²
U value:	1.50 W/(m² K)
Wärmebrücken:	increase U-values of surrounding planes by 0.10 W/(m² K) (normal construction)

Building:

Interior temperature:	20.0 °C
Limit of overheating:	27.0 °C
Ventilation:	
Natural ventilation (infiltration):	0.60 1/h
Mechanical ventilation:	0.00 1/h
Heat recovery (only mech. ventilation):	0 %
efficiency factor of air conditioning:	2.5 kWh_{cool} / kWh_{electr}
Internal gains:	25.0 kWh/(m² a)
Kind of indoor walls:	medium construction
Kind of outdoor walls:	medium construction

Climate:

Climate station:	Athinai (Hellas)

Windows:

North:	
Windows area:	0.0 m²
Fraction of windows area at the facade:	0.0 %
Kind of windows:	others
U value glazing:	1.30 W/(m² K)
U value frame:	2.80 W/(m² K)
g value glazing:	0.80
Fraction of frame:	24.0 %
Shading:	7.0 %
South:	
Window area:	0.0 m²
Fraction of windows area at the facade:	0.0 %
Kind of windows:	others
U value glazing:	1.30 W/(m² K)
U value frame:	2.80 W/(m² K)
g value glazing:	0.80
Fraction of frame:	24.0 %
Shading:	7.0 %
East:	
Window area:	36.2 m²
Fraction of windows area at the facade:	67.0 %
Kind of windows:	others
U value glazing:	1.30 W/(m² K)
U value frame:	2.80 W/(m² K)
g value glazing:	0.80
Fraction of frame:	24.0 %
Shading:	7.0 %
West:	
Window area:	23.2 m²
Fraction of windows area at the facade:	43.0 %
Kind of windows:	others
U value glazing:	1.30 W/(m² K)
U value frame:	2.80 W/(m² K)
g value glazing:	0.80
Fraction of frame:	10.0 %
Shading:	50.0 %

Energy:

Heating system:	low temperature burner, boiler and distribution inside the thermal zone
Heat transfer / system temperature:	radiators (outside walls), thermostatic valves (layout temperature: 1K), system temperature: 70/55°C
Source of energy:	fuel oil

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Output: Overview

Heat energy and cooling demand:

	Heat energy demand in kWh/m²	Cooling demand in kWh/m²
January	4.2	0.0
February	3.9	0.0
March	2.3	0.0
April	0.4	0.4
May	0.0	3.8
June	0.0	9.0
July	0.0	13.9
August	0.0	13.4
September	0.0	8.2
October	0.0	0.8
November	0.3	0.6
December	2.8	0.0
Yearly sum	13.8	50.1

Heating and cooling hours:

	Heating hours in hours	Zero energy hours in hours	Cooling hours in hours
January	715	29	0
February	649	23	0
March	549	195	0
April	236	441	43
May	1	312	431
June	0	114	606
July	0	0	744
August	0	0	744
September	0	209	511
October	0	551	193
November	311	290	119
December	561	183	0
Sum (in hours)	3022	2347	3391
Sum (in %)	34.5	26.8	38.7

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Output: Climate and building data

Climate data:

	Mean temperature in °C	Maximum temperature in °C	Minimum temperature in °C
January	11.6	21.3	0.4
February	10.9	20.5	1.9
March	11.8	22.5	3.1
April	13.9	26.3	1.0
May	18.0	32.5	5.8
June	22.1	37.1	11.2
July	25.6	33.6	16.6
August	26.3	35.6	17.6
September	24.3	36.3	10.9
October	20.5	28.2	10.5
November	16.4	31.5	4.6
December	13.5	26.4	2.7
Yearly mean	18.0		

Building data:

Mean U value:	0.42 W/(m² K)
Specific transmission losses:	255.9 W/K
Specific ventilation losses:	111.5 W/K
Sum specific losses:	367.3 W/K
Thermal inertia:	46.3 hours
Maximum heating load:	6.6 kW
Maximum specific heating load:	38.5 W/m²
Maximum cooling load:	21.0 kW
Maximum specific cooling load:	121.3 W/m²
Limit temperature for heating:	18.5°C
Effective heating days:	196 Tage

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Output: Heat balance

Specific (per m² useful area):

	Transm. losses in kWh/m²	Ventil. losses in kWh/m²	Internal Gains in kWh/m²	Solar Gains in kWh/m²	Usability factor	Heat energy demand in kWh/m²
January	8.1	4.0	1.9	6.0	0.90	4.2
February	7.9	3.9	1.7	6.3	0.89	3.9
March	7.9	3.9	1.7	7.9	0.78	2.3
April	5.7	2.8	1.1	7.0	0.52	0.4
May	1.9	1.0	0.3	2.6	0.15	0.0
June	0.0	0.0	0.0	0.0	0.00	0.0
July	0.0	0.0	0.0	0.0	0.00	0.0
August	0.0	0.0	0.0	0.0	0.00	0.0
September	0.0	0.0	0.0	0.0	0.00	0.0
October	0.0	0.0	0.0	0.0	0.00	0.0
November	3.4	1.7	1.1	3.6	0.55	0.3
December	6.3	3.1	1.8	4.8	0.87	2.8
Yearly sum	41.1	20.5	9.6	38.2		13.8

Absolute (total building):

	Transm. losses in kWh	Ventil. losses in kWh	Internal Gains in kWh	Solar Gains in kWh	Usability factor	Heat energy demand in kWh
January	1395	696	331	1032	0.90	728
February	1368	682	295	1088	0.89	668
March	1365	681	287	1370	0.78	389
April	979	488	186	1213	0.52	68
May	332	165	54	443	0.15	0
June	0	0	0	0	0.00	0
July	0	0	0	0	0.00	0
August	0	0	0	0	0.00	0
September	0	0	0	0	0.00	0
October	0	0	0	0	0.00	0
November	584	291	196	631	0.55	49
December	1080	539	319	822	0.87	477
Yearly sum	7103	3542	1667	6599		2378

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Output: Cooling balance

Cooling demand and overheating:

	Cooling demand specific in kWh/m²	Cooling demand absolute in kWh	Mean overheating in hours/day	Cooling degree hours in Kh
January	0.0	0	0.0	0.0
February	0.0	0	0.0	0.0
March	0.0	0	0.0	0.0
April	0.4	62	1.4	32.0
May	3.8	649	13.9	1447.2
June	9.0	1557	20.2	3591.4
July	13.9	2405	24.0	6139.7
August	13.4	2321	24.0	6236.8
September	8.2	1421	17.0	4003.4
October	0.8	144	6.2	181.3
November	0.6	100	4.0	140.1
December	0.0	0	0.0	0.0
Yearly sum	50.1	8659		21772.0

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Output: Primary and end energy demand for heating

Energy demand of the heating system:

Heat:

Heat energy demand:	13.8 kWh/(m² a)
Losses of the heat storage:	0.0 kWh/(m² a)
Heat losses from the distribution:	2.4 kWh/(m² a)
Looses at the transmission to the rooms:	1.1 kWh/(m² a)
Expense number of heat generation:	1.08
End energy demand fuel oil:	18.7 kWh/(m² a)
Primary energy factor fuel oil:	1.1
Primary energy demand fuel oil:	20.5 kWh/(m² a)

Auxiliary energy (electricity):

Auxiliary energy for heat generation:	0.6 kWh/(m² a)
Auxiliary energy for heat storage:	0.0 kWh/(m² a)
Auxiliary energy for heat distribution:	1.1 kWh/(m² a)
End energy demand auxiliary energy (electricity):	1.7 kWh/(m² a)
Primary energy factor electricity:	3.0
Primary energy demand auxiliary energy (electricity):	5.2 kWh/(m² a)

	End energy demand fuel oil in kWh/m²	End energy demand electricity in kWh/m²	End energy demand total in kWh/m²	Primary demand fuel oil in kWh/m²	Primary demand electricity in kWh/m²	Primary demand total in kWh/m²
January	5.7	0.5	6.2	6.3	1.6	7.9
February	5.2	0.5	5.7	5.8	1.5	7.2
March	3.0	0.3	3.3	3.4	0.8	4.2
April	0.5	0.0	0.6	0.6	0.1	0.7
May	0.0	0.0	0.0	0.0	0.0	0.0
June	0.0	0.0	0.0	0.0	0.0	0.0
July	0.0	0.0	0.0	0.0	0.0	0.0
August	0.0	0.0	0.0	0.0	0.0	0.0
September	0.0	0.0	0.0	0.0	0.0	0.0
October	0.0	0.0	0.0	0.0	0.0	0.0
November	0.4	0.0	0.4	0.4	0.1	0.5
December	3.7	0.3	4.1	4.1	1.0	5.2
Yearly sum	18.7	1.7	20.4	20.5	5.2	25.7

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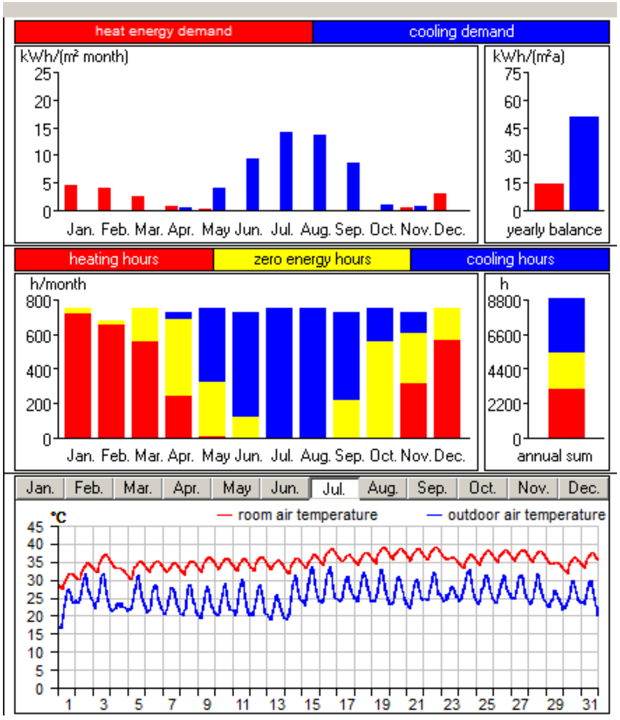
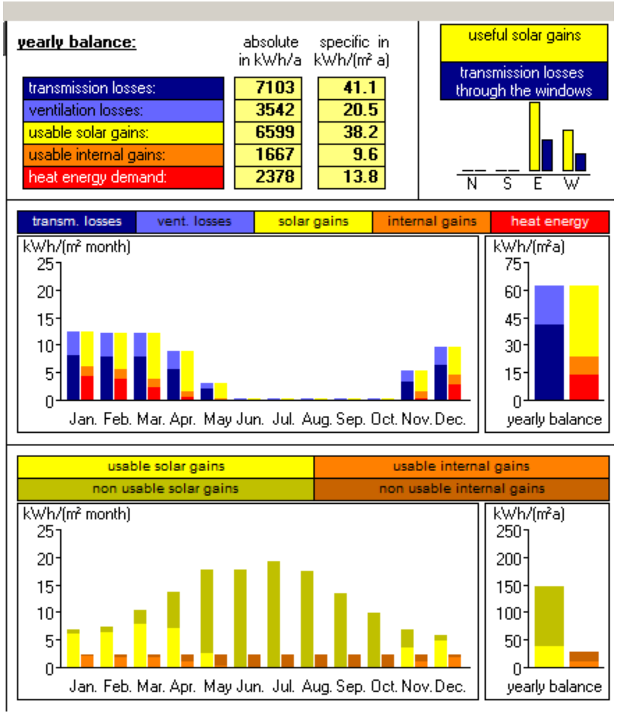
Output: Primary and end energy demand for cooling

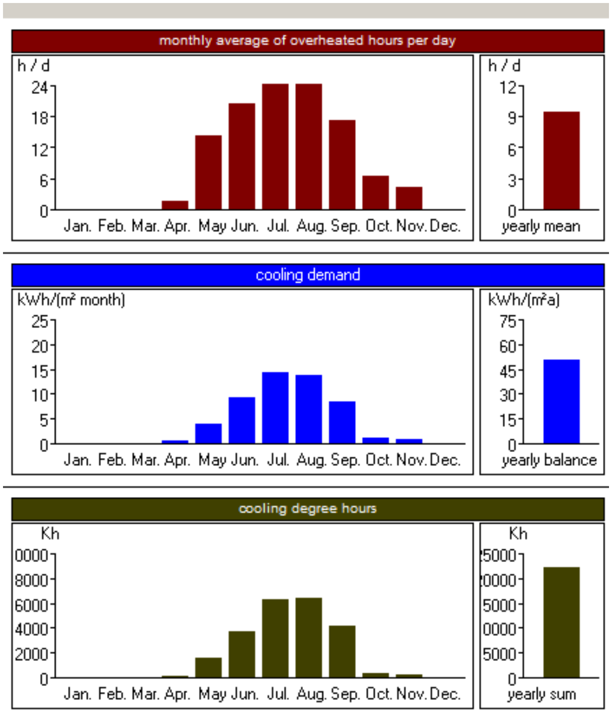
Energy demand of the cooling system:

Efficiency factor of the air conditioning: 2.5 kWh cooling/ kWh electricity

	Cooling demand in kWh/m²	End energy demand for cooling in kWh/m²	Primary energy demand in kWh/m²
January	0.0	0.0	0.0
February	0.0	0.0	0.0
March	0.0	0.0	0.0
April	0.4	0.1	0.4
May	3.8	1.5	4.5
June	9.0	3.6	10.8
July	13.9	5.6	16.7
August	13.4	5.4	16.1
September	8.2	3.3	9.9
October	0.8	0.3	1.0
November	0.6	0.2	0.7
December	0.0	0.0	0.0
Yearly sum	50.1	20.0	60.1




yearly balance:
absolute in kWh/a
specific in kWh/(m² a)
transmission losses: 7103 41.1
ventilation losses: 3542 20.5
usable solar gains: 6599 38.2
usable internal gains: 1667 9.6
heat energy demand: 2378 13.8
useful solar gains
transmission losses through the windows
N S E W
transm. losses
vent. losses
solar gains
internal gains
heat energy
kWh/(m² month)
kWh/(m²a)
Jan. Feb. Mar. Apr. May Jun. Jul. Aug. Sep. Oct. Nov. Dec.
yearly balance
usable solar gains
usable internal gains
non usable solar gains
non usable internal gains


monthly average of overheated hours per day
h / d
Jan. Feb. Mar. Apr. May Jun. Jul. Aug. Sep. Oct. Nov. Dec.
yearly mean
cooling demand
kWh/(m² month)
kWh/(m²a)
yearly balance
cooling degree hours
Kh
yearly sum

*CASA*nova <u>**House type 4**</u>

Data sheet

Geometry:

Length of north and south facade:	12.0 m
Length of west and east facade:	18.0 m
Height (without roof):	3.0 m
Number of floors:	1
Deviation from south direction (west positive):	-45.0 °
Ground area:	216.0 m²
Useful area:	172.8 m²
Volume total:	648.0 m³
Air volume:	518.4 m³
Facade north resp. south:	36.0 m²
Facade east resp. west:	54.0 m²
Surface-to-volume value:	0.9 1/m

Insulation:

U values of the walls:	
north:	0.17 W/(m² K)
south:	0.17 W/(m² K)
east:	0.17 W/(m² K)
west:	0.17 W/(m² K)
Absorption coefficient of the walls:	0.50
Upper floor:	
Towards:	outside or non-insulated roof
U value:	0.20 W/(m² K)
Lower floor:	
Towards:	non-heated cellar (with insulation)
U value:	0.20 W/(m² K)
Door (north facade):	
Area:	0.0 m²
U value:	1.50 W/(m² K)
Wärmebrücken:	increase U-values of surrounding planes by 0.10 W/(m² K) (normal construction)

Building:

Interior temperature:	20.0 °C
Limit of overheating:	27.0 °C
Ventilation:	
Natural ventilation (infiltration):	0.60 1/h
Mechanical ventilation:	0.00 1/h
Heat recovery (only mech. ventilation):	0 %
efficiency factor of air conditioning:	2.5 kWh_{cool} / kWh_{electr}
Internal gains:	25.0 kWh/(m² a)
Kind of indoor walls:	medium construction
Kind of outdoor walls:	medium construction

Climate:

Climate station:	Athinai (Hellas)

Windows:

North:	
Windows area:	0.0 m²
Fraction of windows area at the facade:	0.0 %
Kind of windows:	others
U value glazing:	1.30 W/(m² K)
U value frame:	2.80 W/(m² K)
g value glazing:	0.80
Fraction of frame:	24.0 %
Shading:	7.0 %
South:	
Window area:	0.0 m²
Fraction of windows area at the facade:	0.0 %
Kind of windows:	others
U value glazing:	1.30 W/(m² K)
U value frame:	2.80 W/(m² K)
g value glazing:	0.80
Fraction of frame:	24.0 %
Shading:	7.0 %
East:	
Window area:	23.2 m²
Fraction of windows area at the facade:	43.0 %
Kind of windows:	others
U value glazing:	1.30 W/(m² K)
U value frame:	2.80 W/(m² K)
g value glazing:	0.80
Fraction of frame:	24.0 %
Shading:	7.0 %
West:	
Window area:	36.2 m²
Fraction of windows area at the facade:	67.0 %
Kind of windows:	others
U value glazing:	1.30 W/(m² K)
U value frame:	2.80 W/(m² K)
g value glazing:	0.80
Fraction of frame:	10.0 %
Shading:	50.0 %

Energy:

Heating system:	low temperature burner, boiler and distribution inside the thermal zone
Heat transfer / system temperature:	radiators (outside walls), thermostatic valves (layout temperature: 1K), system temperature: 70/55°C
Source of energy:	fuel oil

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Output: Overview

Heat energy and cooling demand:

	Heat energy demand in kWh/m²	Cooling demand in kWh/m²
January	3.9	0.0
February	3.8	0.0
March	2.4	0.0
April	0.5	0.2
May	0.0	3.0
June	0.0	7.5
July	0.0	12.2
August	0.0	12.4
September	0.0	8.1
October	0.0	1.1
November	0.2	0.7
December	2.5	0.0
Yearly sum	13.3	45.2

Heating and cooling hours:

	Heating hours in hours	Zero energy hours in hours	Cooling hours in hours
January	677	67	0
February	640	32	0
March	557	187	0
April	262	436	22
May	6	346	392
June	0	158	562
July	0	3	741
August	0	0	744
September	0	207	513
October	0	523	221
November	310	273	137
December	561	183	0
Sum (in hours)	3013	2415	3332
Sum (in %)	34.4	27.6	38.0

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Output: Climate and building data

Climate data:

	Mean temperature in °C	Maximum temperature in °C	Minimum temperature in °C
January	11.6	21.3	0.4
February	10.9	20.5	1.9
March	11.8	22.5	3.1
April	13.9	26.3	1.0
May	18.0	32.5	5.8
June	22.1	37.1	11.2
July	25.6	33.6	16.6
August	26.3	35.6	17.6
September	24.3	36.3	10.9
October	20.5	28.2	10.5
November	16.4	31.5	4.6
December	13.5	26.4	2.7
Yearly mean	18.0		

Building data:

Mean U value:	0.41 W/(m² K)
Specific transmission losses:	253.2 W/K
Specific ventilation losses:	111.5 W/K
Sum specific losses:	364.6 W/K
Thermal inertia:	46.6 hours
Maximum heating load:	6.6 kW
Maximum specific heating load:	38.2 W/m²
Maximum cooling load:	15.2 kW
Maximum specific cooling load:	87.7 W/m²
Limit temperature for heating:	18.5°C
Effective heating days:	196 Tage

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Output: Heat balance

Specific (per m² useful area):

	Transm. losses in kWh/m²	Ventil. losses in kWh/m²	Internal Gains in kWh/m²	Solar Gains in kWh/m²	Usability factor	Heat energy demand in kWh/m²
January	8.0	4.0	1.9	6.2	0.89	3.9
February	7.8	3.9	1.7	6.3	0.89	3.8
March	7.8	3.9	1.7	7.6	0.80	2.4
April	5.6	2.8	1.1	6.8	0.55	0.5
May	1.9	1.0	0.3	2.5	0.16	0.0
June	0.0	0.0	0.0	0.0	0.00	0.0
July	0.0	0.0	0.0	0.0	0.00	0.0
August	0.0	0.0	0.0	0.0	0.00	0.0
September	0.0	0.0	0.0	0.0	0.00	0.0
October	0.0	0.0	0.0	0.0	0.00	0.0
November	3.3	1.7	1.1	3.7	0.53	0.2
December	6.2	3.1	1.8	5.0	0.85	2.5
Yearly sum	40.6	20.5	9.7	38.1		13.3

Absolute (total building):

	Transm. losses in kWh	Ventil. losses in kWh	Internal Gains in kWh	Solar Gains in kWh	Usability factor	Heat energy demand in kWh
January	1378	696	327	1070	0.89	677
February	1351	682	294	1083	0.89	656
March	1348	681	293	1321	0.80	415
April	967	488	196	1179	0.55	80
May	328	165	60	433	0.16	0
June	0	0	0	0	0.00	0
July	0	0	0	0	0.00	0
August	0	0	0	0	0.00	0
September	0	0	0	0	0.00	0
October	0	0	0	0	0.00	0
November	577	291	190	636	0.53	42
December	1067	539	313	858	0.85	434
Yearly sum	7016	3542	1673	6580		2305

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Output: Cooling balance

Cooling demand and overheating:

	Cooling demand specific in kWh/m²	Cooling demand absolute in kWh	Mean overheating in hours/day	Cooling degree hours in Kh
January	0.0	0	0.0	0.0
February	0.0	0	0.0	0.0
March	0.0	0	0.0	0.0
April	0.2	35	0.7	15.1
May	3.0	526	12.6	1128.2
June	7.5	1295	18.7	2951.5
July	12.2	2100	23.9	5335.4
August	12.4	2136	24.0	5732.2
September	8.1	1406	17.1	3964.3
October	1.1	189	7.1	259.8
November	0.7	125	4.6	193.0
December	0.0	0	0.0	0.0
Yearly sum	45.2	7812		19579.4

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Output: Primary and end energy demand for heating

Energy demand of the heating system:

Heat:

Heat energy demand:	13.3 kWh/(m² a)
Losses of the heat storage:	0.0 kWh/(m² a)
Heat losses from the distribution:	2.4 kWh/(m² a)
Looses at the transmission to the rooms:	1.1 kWh/(m² a)
Expense number of heat generation:	1.08
End energy demand fuel oil:	18.2 kWh/(m² a)
Primary energy factor fuel oil:	1.1
Primary energy demand fuel oil:	20.0 kWh/(m² a)

Auxiliary energy (electricity):

Auxiliary energy for heat generation:	0.6 kWh/(m² a)
Auxiliary energy for heat storage:	0.0 kWh/(m² a)
Auxiliary energy for heat distribution:	1.1 kWh/(m² a)
End energy demand auxiliary energy (electricity):	1.7 kWh/(m² a)
Primary energy factor electricity:	3.0
Primary energy demand auxiliary energy (electricity):	5.2 kWh/(m² a)

	End energy demand fuel oil in kWh/m²	End energy demand electricity in kWh/m²	End energy demand total in kWh/m²	Primary demand fuel oil in kWh/m²	Primary demand electricity in kWh/m²	Primary demand total in kWh/m²
January	5.3	0.5	5.9	5.9	1.5	7.4
February	5.2	0.5	5.7	5.7	1.5	7.2
March	3.3	0.3	3.6	3.6	0.9	4.5
April	0.6	0.1	0.7	0.7	0.2	0.9
May	0.0	0.0	0.0	0.0	0.0	0.0
June	0.0	0.0	0.0	0.0	0.0	0.0
July	0.0	0.0	0.0	0.0	0.0	0.0
August	0.0	0.0	0.0	0.0	0.0	0.0
September	0.0	0.0	0.0	0.0	0.0	0.0
October	0.0	0.0	0.0	0.0	0.0	0.0
November	0.3	0.0	0.4	0.4	0.1	0.5
December	3.4	0.3	3.8	3.8	1.0	4.7
Yearly sum	18.2	1.7	19.9	20.0	5.2	25.2

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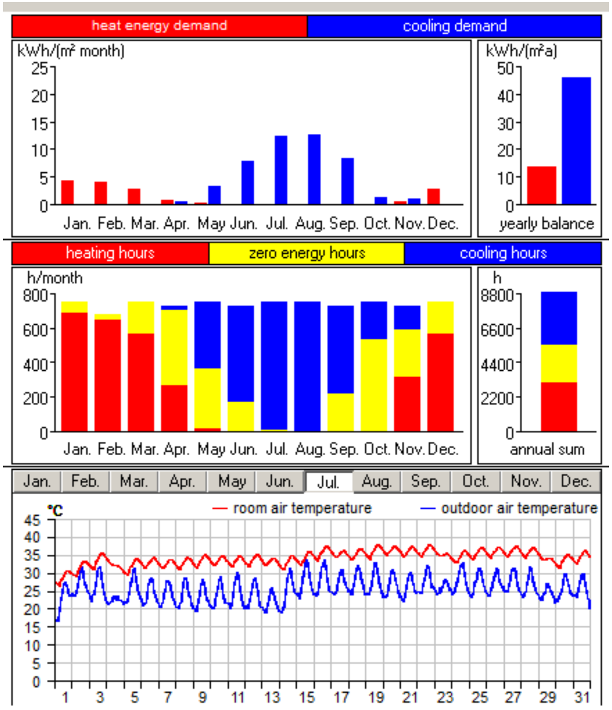
Output: Primary and end energy demand for cooling

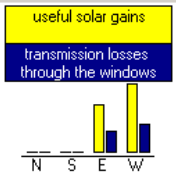
Energy demand of the cooling system:

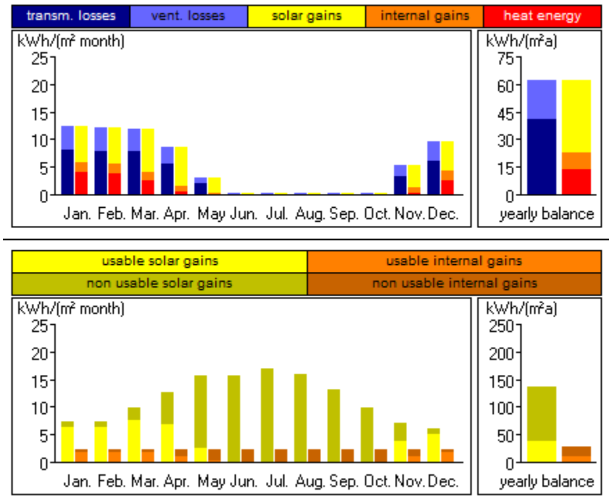
Efficiency factor of the air conditioning: 2.5 kWh cooling/ kWh electricity

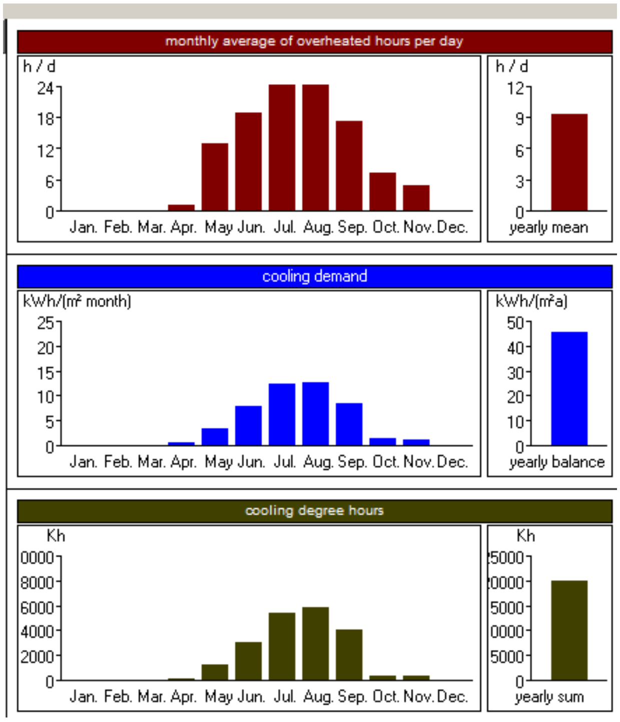
	Cooling demand in kWh/m^2	End energy demand for cooling in kWh/m^2	Primary energy demand in kWh/m^2
January	0.0	0.0	0.0
February	0.0	0.0	0.0
March	0.0	0.0	0.0
April	0.2	0.1	0.2
May	3.0	1.2	3.7
June	7.5	3.0	9.0
July	12.2	4.9	14.6
August	12.4	4.9	14.8
September	8.1	3.3	9.8
October	1.1	0.4	1.3
November	0.7	0.3	0.9
December	0.0	0.0	0.0
Yearly sum	45.2	18.1	54.2



yearly balance:	absolute in kWh/a	specific in kWh/(m² a)
transmission losses:	7016	40.6
ventilation losses:	3542	20.5
usable solar gains:	6580	38.1
usable internal gains:	1673	9.7
heat energy demand:	2305	13.3







From this analysis, the following table can be obtained:

House type	Yearly heating energy demand kWh/m^2	Yearly cooling demand kWh/m^2
1	9.3	59.6
2	7.0	**70.9**
3	**13.8**	50.1
4	13.3	45.2

Because un of the purposes of the project is to have modular construction, the energy demands chosen for every single unit in the complex will be 13.8 kWh/m^2 for heating, and 70.9 kWh/m^2, since these are the highest loads and therefore the ones that can fulfill the needs of any house unit, despite of its size and position.

Cooling system:

Cooling is very important in an area like Tehran. Since it has very warm and dry summers. The traditional ways of coling in iranina houses were wind catchers and having water elements in the courtyard with cross ventilated windows.

The winds coming from north west and north east usually carries a cooler effect cause they come from the mountains. The blocks of buildings in this project has been located in a way that the cross windows on both side of each living unit is facing these two directions.

In addition to that a wind catcher is added to each block in order to catch the wind in a higher level since the blocks of residential complex might not be high enough to catch all the wind there is.

The oldest cooling system in the world has been the windcatchers. They usually were combined with a water element in order to refresh, cool and humidify the air before blowing inside the house. The more updated cooling system similar to windcatchers is evaporative or swamp cooling system.

- The evaporative cooler cools the air around by the natural process of water evaporation in simple air moving system.
- The air from the outside is sucked inside and cooled by the moist pads through evaporation and is then circulated outside by a large blower.
- This makes it very effective in lowering the temperature of the outside air by as much as 30 degrees.
- They are also known as swamp coolers because they add moisture to the air and blow it around.

- However, these coolers are less effective in high humidity. It works best when the air is dry, like a desert-like environment.
- The main mechanism of its working is that dry air absorbs some water, and the heat of the air evaporates the water, thereby making the air cooler.

The Mechanism Of An Evaporative Cooler

- The cooler consists of a large fan and water moistened pads. The pads are positioned in front of the fan.
- The fan sucks the warm air through the pads and then blows out the cooled air through the house.
- The pads are made of absorbent materials that can hold the moisture without developing mildew growth.
- The most common material is the wood shavings of aspen trees. These pads must be replaced every season.
- The pads are connected with small lines to supply the water at the top of the pad. The pad soaks in the water and trickles down to a sump in the bottom, which is then sent to the top by a small water pump.

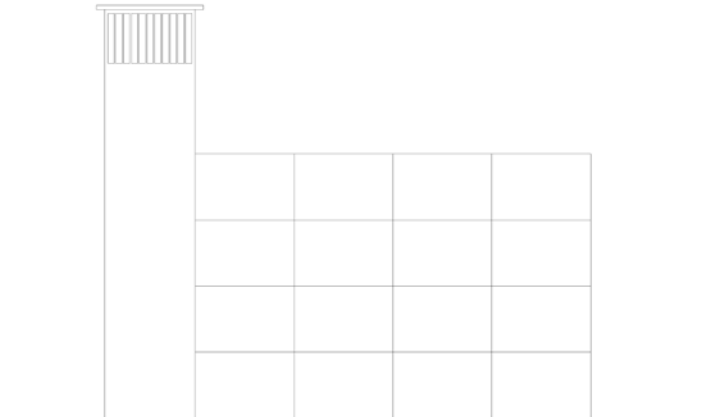
Advantages Of Evaporative Cooling

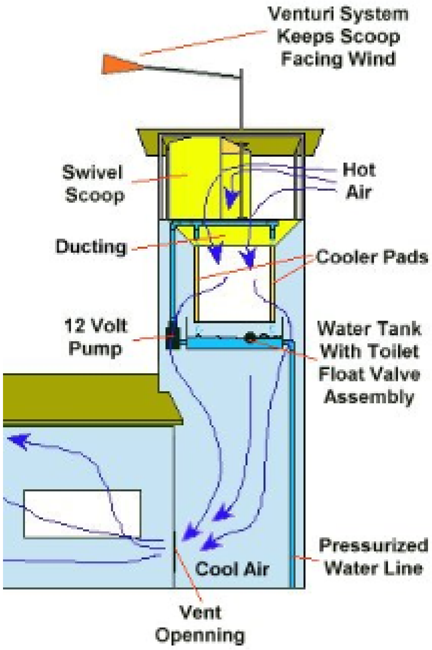
- These types of coolers use as much as 75% less electricity than an air conditioner. So, it is more energy efficient and can result in huge savings especially in hot desert climates.
- It is also very cost effective as the technology is very simple though the installation costs are nearly the same as air conditioning units.
- Unlike air conditioners, evaporative coolers do not require high amperage circuits as they operate on 120-volt electricity. It can be plugged into any household outlet.
- The moist pads are also very good air filters, which can effectively trap dust and pollen. They are also very inexpensive as compared to the filters of air conditioners.
- The evaporative coolers add moisture to the house, which can keep the wood furniture and fabrics from drying out.
- It does not require extensive ductwork like air conditioners to distribute the air. Smaller units can be placed on the window with very little installation.

In this project I combined these systems and created a low energy cooling system with the use of natural wind for the internal space. an effective height for a wind catcher is around 25m. It can receive wind from any direction but in this project the desirable winds are from north, north west and north east, The winds which come from the mountains, clean and pollution free. A dust proof net at the beginning of the neck of the wind catcher will make sure that nothing unwanted get inside the air channel. The internal surfaces of the wind catcher are covered with cooler moist pads. They are kept moist with small lines to supply the water at the top of the pad. The pad soaks in the water and trickles down to a sump in the bottom, which is then sent to the top by a small water pump. There are individual air vents which carry the cooled air into each units, each equipped with fan in order to help with the process if its necessary.

A traditional wind catcher had 1 to 2 meter deep opening on the top part to let the wind in. this opening always divided to smaller openings called springs. Each spring is approximately 40 to 60 cm wide. And each space according to its size had a number of springs. For example a room 3 meter wide had a wind catcher with 5 springs. A 5 m wide had 7, and 7 meter had 11 springs.

The dept of the openings couldn't be more cause of the structural failure, in order to strengthen of the structure each half of a meter there is a wooden frame placed in the internal part of the wind catcher in order to prevent it from breaking. The material of this wind catcher is thermo poly rock since it has a better strength than concrete and its thermal conductivity is low so the air inside the tower would stay cool. The structure is simply 4 steel circular profile columns with 5.5 m beam spans locating in each 5 meter height.



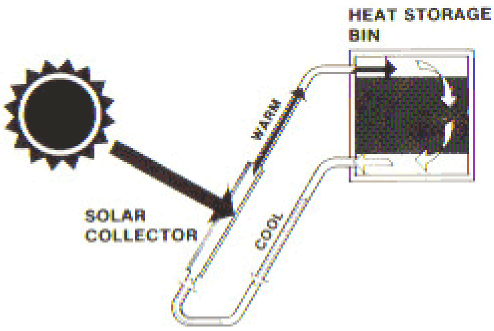


Heating system:

An iranian house floor is always covered with fine carpets. Which is a very good insulative material and add to the warmth in th winter. Any heating under pavements heating system cant be useful in an Iranian home due to this fact.
What is very popular to use as a heating device in houses in iran is radiators, and since the gas is very cheap the heating of the water running through this system is done with gass. These days radiators come in very interesting designs for homes and offices. And there are ways to help reduce the energy used for this kind of heating. For example Tehran is a city that has lots of sun during the whole year. Even in winter there is a lot of solar energy that can be used.

ISOLATED GAIN

Finally, the isolated gain design approach uses a fluid (liquid or air) to collect heat in a flat plate solar collector attached to the structure. Heat is transferred through ducts or pipes by natural convection to a storage area - comprised of a bin (for air) or a tank (for liquid), where the collected cooler air or water is displaced and forced back to the collector .



If air is used as the transfer medium in a convection loop, heated air coming from the collector is usually directed into a rock (or other masonry mass material) bin where heat is absorbed by the rocks from the air. As the air passes its heat to the rocks it cools, falls to the bottom of the bin and is returned to the collector completing the cycle. At night the interior space of the structure is heated by convection of the collected radiant energy from the rock bin. If water is the transfer medium, the process works in much the same way except that heat is stored in a tank, and as hot water is introduced, cooler water is circulated to the collector. In naturally occurring convection systems (non-mechanically assisted) collectors must be lower than storage units, which must be lower than the spaces to be heated (RT). Of course, the addition of distribution assisting equipment can allow for placement of system elements anywhere, but that would then be an Active Solar System.

Don't we appreciate our modern lives, where everything in our house has a great functionality and a stunning appearance that is both uncomplicated and simple. The radiators are manufactured from Olycale Stone which is a known radiant alternative to metal. In other words, it keeps heat in. Naturally, Olycale Stone is white in color which is then borken down and formed again to make it suitable for highly efficient heating. This basic quality forms the structural backdrop of the radiator, which is later given a dash of vivid colors.

As mentioned before, decorative characteristics for interior of an iranian home is a necessaty to its identity. The house is kept like a shrine to the most important icon of the society which is family. In traditional spaces, cast iron is where it’s at. The Cast Iron Reclamation Company carries gorgeous, old school radiators models.

 the vertical decorative radiators can have covers with any design. They don’t accupy much of a space and they are beautiful to look at.

The model:

1. the structure is totally independent and flexible for further various uses
2. the units are made out of recycled waste, and in the model they are covered with pieces of newspapers and magazines symbolizing this concept
3. the facades are holding traditional design principles and windows are double glazed orosi.
4. the units can move, change, add and subtract... and the space between them is filled with green slabs holding semi open green spaces for common use.
5. the covers of the built units are in harmony with their use which is a symbolic effect in the model. for example the windward which function as an evaporate cooling system, has pictures of water, shadows, and colours mostly in blue, to represent a cooling effect and use of water.
6. the eslimi wooden panels on top of the units hide the structure and also the service systems of each units which is placed on top of it.