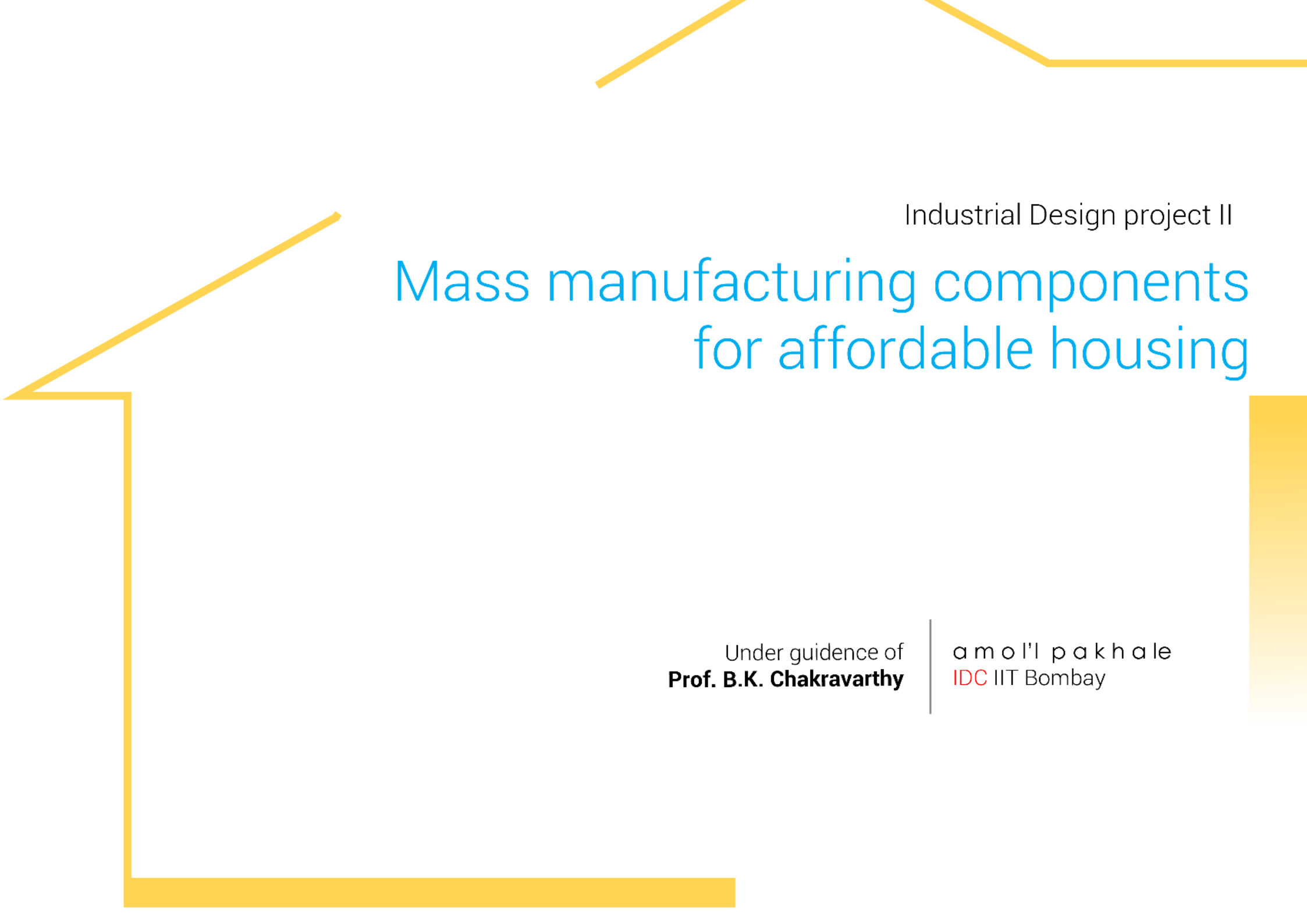




Industrial Design project II

Mass manufacturing components for affordable housing

Under guidance of
Prof. B.K. Chakravarthy

amol I'pakhale
IDC IIT Bombay

Acknowledgement

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Finally, I thank IDC staff for the invaluable support with the facilities.

Declaration

I declare that this written submission represents my idea in my own words and where other ideas or words have been included. I have adequately selected and referred the original source. I also declare that I have adhered to all principles of academic honesty and integrity and have not misinterpreted or fabricated or falsified any ideas / data / facts / sources in my submission.

I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the source that have not been properly cited, or from whom proper permission has not been sought.

Signature



Name

AMOL PAKHALE

Roll no

126130002

Date

30-12-2013

Approval

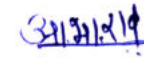
Industrial Design Project II "Mass manufacturing building components for affordable housing"

By : Amol Pakhale
M.Des Industrial Design 2012-2014

Is approved as a partial fulfillment of
requirements of post graduate degree in



Prof. B.K. Chakravarthy
(Project Guide)


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Abstract

Now a day's houses are not affordable due to high land value and lack of mass production in building components. Mass production not only reduces the price of component but it also provides high quality surface finish at very less period of time.

The idea is to design and develop mass producible building components like door – window, balcony, staircase, plumbing and electrical systems etc, which can help us to reduce the overall cost and time during construction, which would help us to make houses affordable for lower middle class people.

Many cost effective and time saving

alternatives are explored prior to implementation of mass manufacturing components for housing during this program and that could be implemented with high time and high technological research. Some of these alternatives may be discarded after little study; some appear immediately attractive; and others must be studied at some length before their attractiveness can be evaluated. This project identifies the need of a faster system of housing delivery and attempts to determine the appropriate form, process and techniques for industrialized housing, which can cater the need, in Indian context.

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Introduction

Urban area house nearly 31.12 % of India's population. An urban area as a census 2011 states is where most of the working population is not engaged in agricultural pursuits. The population in urban areas is growing at the rate of 31.80%. A significant component of this growth is caused by large scale urban migration.

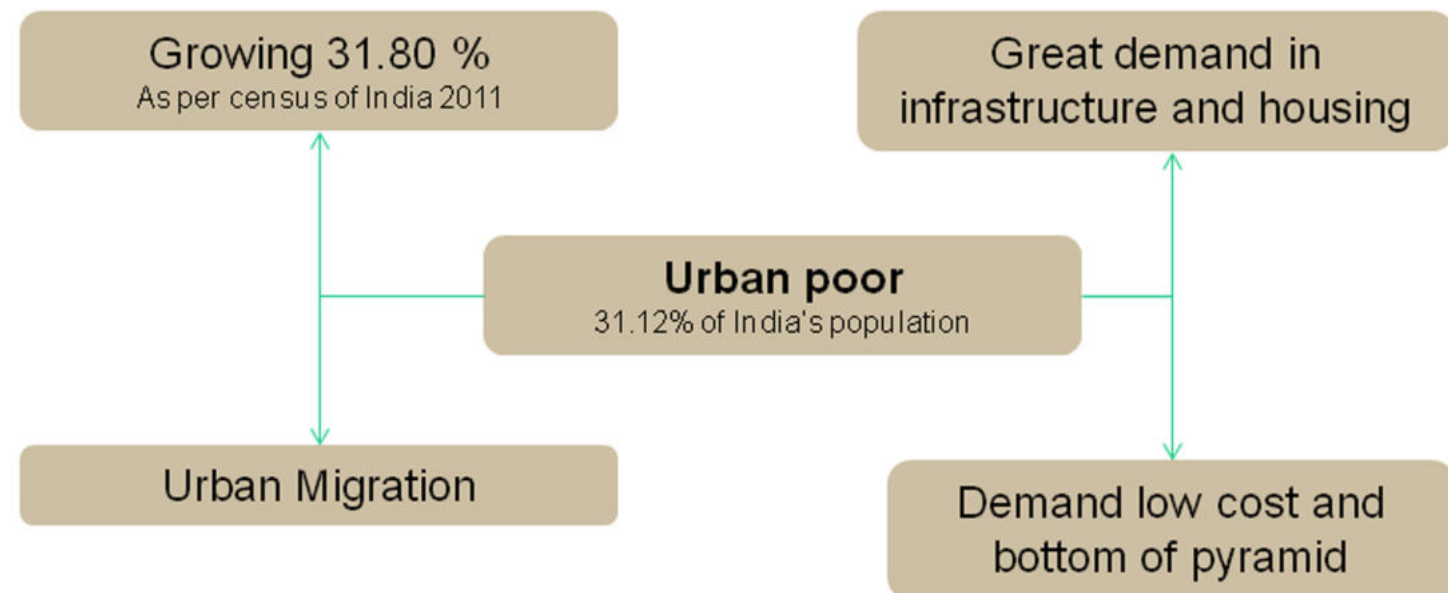


Fig.1 Introduction

The huge influx of migrant population into urban centers is placing a great demand on urban infrastructure, particularly housing. Similarly demand of skilled and unskilled labor has increased the demand for low cost and bottom of pyramid housing. There is no dearth of developers targeting middle and high income group housing segment.

Mass production of houses are built out of boxes, called modules, which are constructed off site or on site transported to a building lot, and assembled into a finished home. All of the materials - from framing, roofing, and plumbing to cabinetry, interior finish, and electrical - are identical to what you would find in a conventional "stick-built" home. The most striking thing about a mass production of building components is not anything you can see, nor how it is made, but where it is made: in a modern factory designed to build good-quality homes.

The Factory Advantage

The mass production system combines engineering know-how and factory-production methods to design and build more efficiently and with greater quality control. When done well, the efficiency results in lower costs and the quality control results in a better product. The idea of building homes, especially the components that make up a home, in a factory is not a recent phenomenon.
(13114)

Design brief

The **objective** of this project, within the overall study, is to generate possible design alternatives for mass production of building components and techniques for the construction of affordable housing.

Need of product

This labor shortage has eroded craftsmanship, driven up prices, and caused delays, shoddy construction, and unhappy homeowners. Frustrated by these problems, custom stick builders have turned to modular homes as a way to introduce some control into the building process. Modular manufacturers have, in turn, enticed them by presenting new house plans that meet the needs of builders' style-conscious customers.

Many consumers assume that the primary advantage of modular technology is

lower prices. That is only the third most important reason for building a modular home. Faster construction time is the second, and superior quality is the first.

Building home with mass production components will normally save you time compared with building a conventional stick-framed house. Saving time on construction not only saves money, it also reduces the stress involved in home building. The faster you build your home, the sooner you will be able to enjoy it and dispense with the worries and preoccupations of construction.

The Modular Advantage in Cost

Manufacturers of affordable homes are usually able to build new house plans more than custom stick builders, for the same kinds of reasons that automobile manufacturers are able to build a new car for far less than a mechanic could build the same car in his garage.

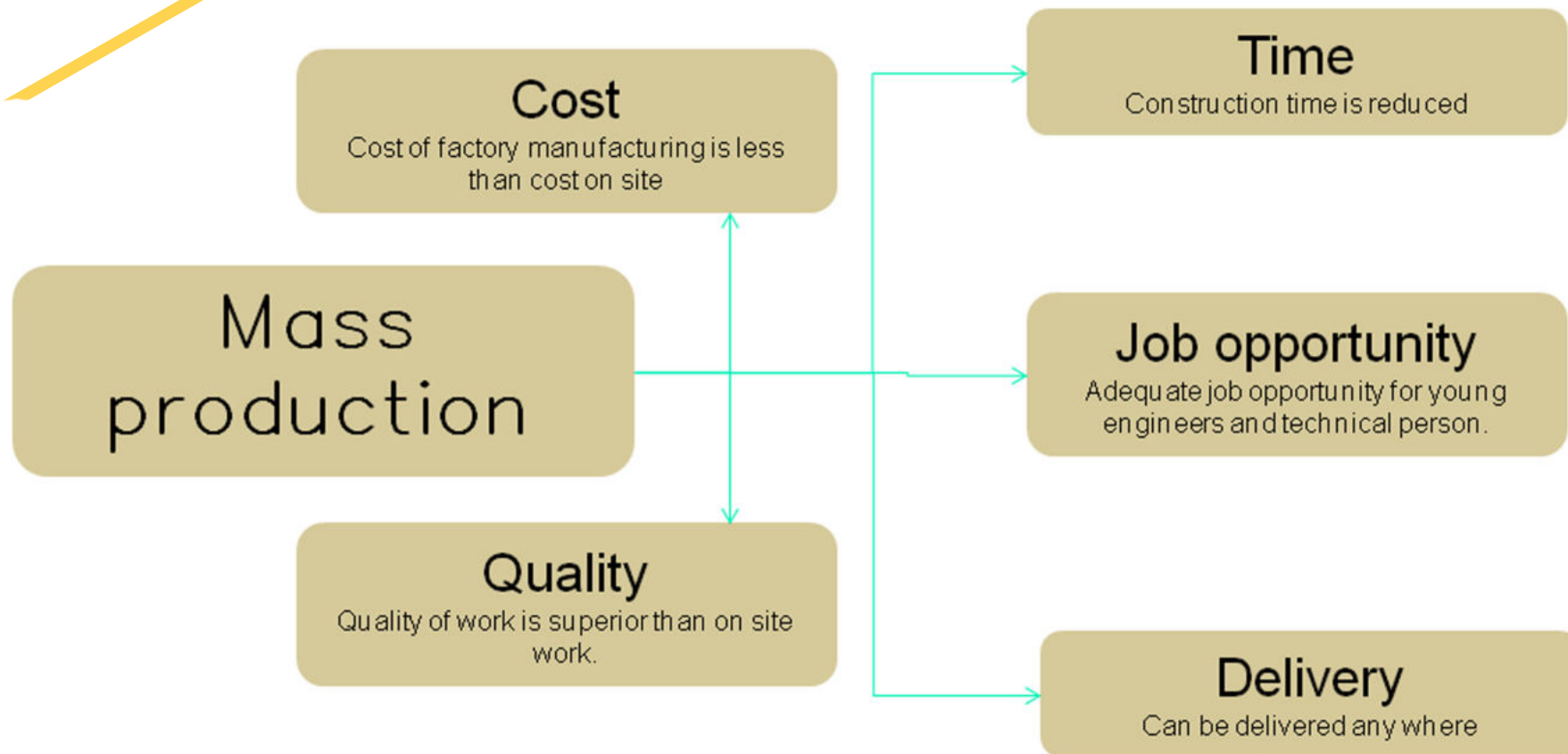


Fig.2 Need of product

They include:

- Volume purchases of materials, which allows mass manufacturers to secure significant discounts
- Organizing the construction process with inventory controls, power tools and equipment, and quality-control systems enables the factory crews to produce a home with greater efficiency than a handful of construction workers building in the field.
- Less waste: By working with standardized dimensions, modular manufacturers are better able to make optimal use of materials and avoid waste.

Scope

- This project can be used as a disaster management program, and it is very beneficial at time of rehabilitation, fast construction during refugee camp.

- This project will also promote management and design activities that are directly associated with the construction processes.
- Scope for appropriate prefabricated building system to fulfill the housing shortage in India must be reassessed in present context

Limitations

- Due to limited period of time full scale model of final concept is not possible.
- Structural analysis of the whole component cannot be fetched.
- Estimation of time consumption and cost reduction are not possible to provide.
- Specific details and material testing shall not to be covered, so user feedback is not possible,
- This project is restricted to technology and material currently available in Indian scenario.

The advantages of mass production of building components

- The cost of mass production is less compared to the cost on site.
- The quality of work is superior since the work is performed sheltered from the elements and controlled at every step of construction.
- The strength of the structure is greater due to the modular design, which is self-supporting.
- Construction time is reduced.
- Plumbing, ventilation and electricity are in place and ready for site connection.
- The modules are ready to receive interior and exterior finishes.
- The total actual cost is lower for higher quality.

Mass manufacturing component

The process of building typical designed units or component (building) in a large quantities using mass production. In this type of techniques small pieces of components are assembled on site, though similar in some ways and can be attached in a different manner, so that it can be used for constructing homes.

These components can be various shapes and sizes. Instead of being two halves like double wide, they are built for fit together like puzzle pieces. So that components used for such type of construction are mass manufacturing building components.

Product analysis



Fig.3 Modular windows

Modular Windows

Now windows are made in factories with some standard sizes we just need to transport and assemble it on site. So that it reduces the cost and increase the quality and precision of product.

These designs can easily adopt any style of home providing operation and performance features that can be matched by other operating windows.

These upvc windows have various designs and can be made and customized as per the client's requirement. There are windows systems with single track, double track, and multiple track with provision of dust and moisture proof wire mesh and glass shutter with modern locking, technically durable no clocking of shutters air tight sound proof and suitable to

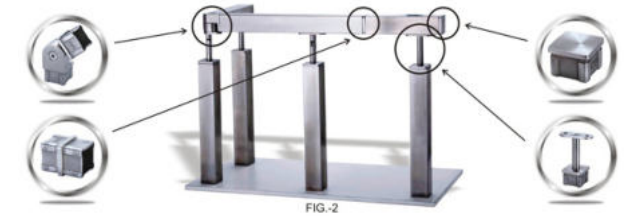


Fig.4 Modular railing

weather condition. There are various types of glass can be used like tinted, sun ban reflective etc, according to user needs.

Modular railing system

Modular railing system is a factory made railing system with custom capabilities of architectural railing and grills has the finest skilled craftsmen working with stainless steel railing from design engineering though fabrication and installation. Architectural Railings & Grilles provides non-welded assemblies using machined parts and other collateral materials that are interchangeable within the railing system. Distinctive looks may include combining stainless and painted aluminum posts and fittings. Top cap selections range from stainless and aluminum to wood.(13111)

Fig. 3 <http://2.imimg.com/data2/YW/QA/IMFCP-2407644/modular-windows--250x250.jpg>

Fig. 4 <http://www.heritageornamentals.com/images/FIG.-3a.jpg>



Fig.5 Pavers

Pavers

Pavers are basically interlocking components which are made by precast piece of concrete and distinctly used for outdoor landscaping for pavement applications. Interlocking paving stones are installed over a compacted stone sub-base and a leveling bed of sand. Concrete paving stones can be used for walkways, patios, pool decks and driveways and airport or loading docks. Instead of connecting the pavers by pouring grout between the joints as one would with tiles, sand particles are spread over the pavers and tamped down. The sand stabilizes the interlocking pavers, yet allows for some flexibility. This type of pavement will absorb stress such as small earthquakes, freezes and thaws, and slight ground

Fig.5 http://lovelytiles.com/yahoo_site_admin/assets/images/ZIG_ZAG.155123500_large.jpg
 Fig.6 http://www.core77.com/blog/object_culture/ascendings_building_a_better_staircase_using_modular_components_18244.asp
<http://s3files.core77.com/blog/images/2011/01/0ascen01.jpg>



Fig.6 Modular staircase

erosion by flexing. Therefore, they do not easily crack, break or buckle like poured asphalt or poured concrete. (1311)

Modular staircase

Simple metal and hardwood space saver staircase kit made by an Italian company called Ehleva. The build quality is reasonably good and it is a fairly straight forward job to assemble it. Assembly can usually be carried out in a single day using standard tools. The modular staircase can be arranged into many different formats such as a straight flight, an L shape or a U shape, and so can be adjusted to suit most houses. For more information please read the height and layout tab. The treads and handrail are made from beech (a good quality hardwood). They have been factory finished with two coats of a tough

polyurethane varnish. This can either be a clear varnish or varnish mixed with a dark stain. The balusters, carriage modules, fixing plates and support column are made from steel. They are powder coated and colored white, grey or black.(Modular staircase n.d.)



Fig.7 Toilet cubicle

Toilet cubicle

Toilet cubicle is a system where the whole toilet come with the set of partition wall, fixtures, plumbing, bathtub, wc etc. these are basically factory made toilets with new age conceptual washroom décor light weight with high aesthetics in low cost. It is fast and flexible system as per today's user needs. Now it is completely eliminating the bulky messy bricks and tile concept and enabling more space without any labor job and stress of onsite construction. It also allows you to freedom of design and blends into any décor with an array of color.

Fig.7 http://www.luxurylaunches.com/wp-content/uploads/2012/12/Cool_bathroom_1.jpg

Vbhc

VALUE & BUDGET HOUSING
CORPORATION PVT LTD
Live happily ever after!



Fig.9 1Bhk apartment view

The 1-BHK Regular apartment is priced at Rs. 11.8 lac onwards and comprises a living room, kitchenette, bedroom, toilet and utility space with airy balconies. It provides a great value proposition as it has a great blend of optimal space utilization and good design. The 1-BHK Deluxe is priced at just Rs. 17.4 lac onwards and provides utmost comfort and an elegant lifestyle. Paying a lot of attention to design and detail, we have meticulously planned the different zones for various urban household activities.

Fig.9 <http://www.vbhc.com/images/palghar.jpg>
[http://www.vbhc.com/campaigns/festivespecial/
 images/palgharII-mumbai/masterplan3.jpg](http://www.vbhc.com/campaigns/festivespecial/images/palgharII-mumbai/masterplan3.jpg)

Plan of unit

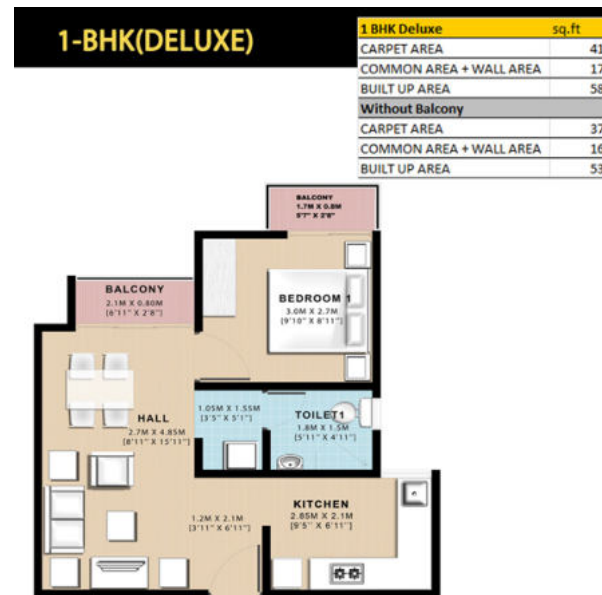


Fig.10 1 Bhk unit plan



Fig.11 2 Bhk unit plan

At VBHC Vaibhav Palghar, VBHC is offering two variants of homes–

1-BHK Regular and 1-BHK Deluxe.

(VBHC apartments n.d.)

Type	Blocks	Total apartment
1 bhk	1	40
1 bhk Deluxe	7	270
Total	8	310

Fig.10 <http://www.vbhc.com/campaigns/festivespecial/images/palgharII-mumbai/1bhk.jpg>

Fig.11 <http://www.vbhc.com/campaigns/festivespecial/images/palgharII-mumbai/2bhk.jpg>

Technology VBHC is using Engineered Metal Forming Systems for Concreting



Fig.12 Formwork technology

Forms are pre-fabricated and engineered modules of shuttering panels with a metal frame and thin contact surface, such as aluminum or steel. A series of forms are joined together edge-to-edge and spaced in parallel with a second series of forms. As per the structural design, steel reinforcement is placed inside the forms. Wet concrete is poured in this space to make walls, floors and ceilings. After the concrete within the formwork strengthens, the formwork can be dismantled. On removal of the formwork, a high quality monolithic concrete structure with accurate tolerances and verticality is produced. The superior (machined) tolerance of the forms gets reflected on the finishes. This means that no

further plastering (external or internal) is required. Furthermore, buildings that use metal forms for cast-in-place structures provide a higher level of performance with greater durability and seismic tolerance compared to traditional brick and mortar construction. In India, metal forming systems are being used only for very expensive apartments. Vaibhava is the first instance where metal forming systems are being used for a budget housing project. After reviewing different forming technologies, we decided to opt for aluminum forms. Aluminum forms have many advantages: High speed of construction, high strength (concrete pressures of 60-85 kN/sq. meters), quality of finish and durability. Weights of standard forms are a little over 30 kg., allowing for ease of handling. Wastage of material with aluminum forming is low. With about 8 per cent of the earth's crust consisting of aluminum, it is one of the few metals in which the availability of raw materials is literally unlimited. What's more, aluminum can be recycled repeatedly for the same uses, without losing its unique properties. Besides, recycling requires only 5% of the original energy input (and CO2 emission).(VBHC n.d.)

User



Fig.13 Users

Users study

This analytical survey was made for mass production techniques and components which is most suitable for engineers and labors and an orientation for future design and development.

User survey					
properties	Low tooling	Transportation cost	Low care	Minimum parts	Easy intallation
User 1	7	2	5	3	5
User 2	6	6	7	4	5
User 3	4	4	5	1	3
User 4	2	5	7	2	7
User 5	7	6	6	2	4
User 6	4	5	4	1	5
User 7	4	2	3	6	6
User 8	3	4	2	5	4
User 9	2	4	6	4	5

Fig.13 <https://www.facebook.com/photo.php?fbid=737063739652638&set=a.737063736319305.1073741827.737047592987586&type=1&theater>
<http://graphics8.nytimes.com/images/2013/05/14/world/asia/14-Chile-family-IndiaInk/14-Chile-family-IndiaInk-superJumbo.jpg>
http://2.bp.blogspot.com/-gidG7_CsqzI/T2azVVswTwI/AAAAAAAAAn0/0HdBPuKOvZ0/s1600/Indian-families.jpg
<http://www.venkatmails.com/wp-content/uploads/2009/04/three-contractors.jpg>

User aspirations

mujhe kamse kam 2bedroom chahiye
open area jyada chahiye
natural cross ventilation ..
normal size room, chote nhi
privacy from other flats
bachcho k liye khelne ki jagah

Safe,

Proximity from daily needs, and location

1 kitchen with 2-3 lofts in walls to keep extra
utensils which we use rarely.
OR if u can provide modular kitchen in
low price
Wash basin should be there.

Wall would be water proof.
Prevented from insects.
High quality water supply and drainage system.

Modular components

Less spaces but good **finished surface.**

Tiles will be there in kitchen and bathroom.

Finished wall

Underground wiring and plumbing system.
Good sanitary finishes.
Attached toilet.

Adequate services like **sanitary, water supply**, drainage, and security will be there.
Optimize ventilation.

Space can be less,
Sufficient water supply.
Common space should be there,

Quality of material.

Toilet piping, electrical line problem, water leakage,
Some **hygiene issue** should be resolved

It should be 2 bhk flat with more space.
Water supply 24 hr.
Electrical layout.

1 Indian toilet and 1 western.

Kitchen can be simple.
Spaces should be more clean.

It should be clean and clear.

Maintenance ka tension nai chahiye.

Saste material use nai hone chahiye.
Location achchi honi chahiye.

User perception



Fig.14 Furniture

Incremental furnishing

Modular or folding seems to be preferred in slums and low cost housing and it is easy to incrementally add on. It is possible to standardized internal house components to allow greater flexibility and internal incremental changes.



Fig.15 Wall finish in Indian low cost houses

Maintenance free choices

Slum dwellers believe in maintenance free products and features. Stainless steel, kadapa racks and steel cupboards are proffered to custom made articles. Finishes need to minimize maintenance.



Fig.16 Multiple usage of furnitures



Fig.17 Low cost maintenance free typical choices

Fig.14 <http://www.jumpthegap.net/projects/pic21.jpg>

Fig. 15 shenoy innovation studio

Fig. 16 <http://www.bowdoin.edu/faculty/s/sdickey/images/anjalis-office.jpg>

Fig. 17 shenoy innovation studio



Fig.18 Partially finished wall and floors



Fig.19 Wall treatment and electrical wiring

Inferences

- Less space with more activities.
- Creative utilization of 3d space.
- Repetition of same component.
- Integrated or combined living space.
- Two or more function with the same component.

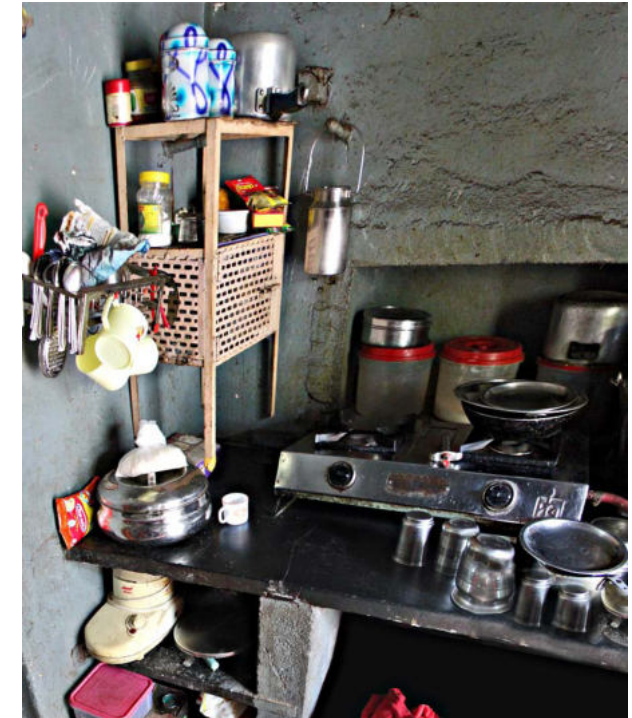


Fig.20 3 dimensional usage of space

- Standardization of the component like staircase, door, window, wall, electrical layout.
- Modularity with low maintenance components.
- Less installation time for components.
- Mass production using the same technique.
- Streaming of the supply chain and design to construction management.
- Easy transportation without damaging parts.

Fig.18 <http://3.bp.blogspot.com/-79oU3SZXkV8/UIOBbFYMoXI/AAAAAAAAAGpY/pekD5t1N9Yc/s640/consumer+goods+in+rural+india.jpg>
 Fig.19 http://2.bp.blogspot.com/-GwZxL47Sw6U/Uba4VQvSXAI/AAAAAAAAJho/eqQM_5vCIHU/s1600/photo+frames.jpg
 Fig.20 http://4.bp.blogspot.com/-q3PjIjQK-3A/UF8SSrIh_WI/AAAAAAAAAF-8/STPAuBZE3Z0/s1600/kitchencounter.jpg



Fig.21 Low maintained toilet



Fig.22 Unfinished surfaces

Factors which affects construction costs:

- Labor
- Materials
- Methods
- Equipments

Fig.21 http://www.timeslive.co.za/Feeds/ipad_images/2012/12/04/ttp8toilets05-04-12-2012-18-12-04-324-.jpg/ALTERNATES/crop_630x400/TTP8TOILETS05-04-12-2012-18-12-04-324-.jpg
 Fig.22 http://3.bp.blogspot.com/-PC10C5Pv_VE/UIfa0SGdkDI/AAAAAAAAAGwE/osVf1YSByl8/s640/wash+basin.jpg

VBHC, Palghar site visit



Fig.24 How shutters are joined together



Fig.23 Techniques of using shutter



Fig.25 Scale of the project



Fig.26 Wall section shutter detail



Fig.27 Placing switch board and pipes



Fig.28 Detail of joining shutters



Fig.29 Shutter parts



Fig.30 Completed units

Conference of Ambuja cement & Acc cement

Venue: Hotel grand Maratha, Mumbai.

ALCCOFINE 1101 is a special product used in special kind of applications demanding high performance such as soil stabilization and rock anchoring etc. It is Micro fine material cementitious grout with much finer particle size. It is produced in a controlled environment with special equipments to achieve specifically designed particle size distribution (PSD) of the material which gives it the unique properties.

Fields of Applications

- Rock injection: Tunnels, caverns, mines, etc.
- Used for pre and post excavation injection.
- Ground water sealing and ground stabilization.
- Soil injection: Ground stabilization and ground water sealing
- Prepacked injection
- Contact injection

(Alcofine micro materials 2013)

EcoCrete is here with a Classified Fly Ash unit which boasts of totally indigenous technology and a state of the art R & D operation. Providing builders and manufacturers with processed and quality controlled Fly Ash, EcoCrete. (Ecocrete n.d.)

Coolcrete concrete stain can be applied to new or old concrete. The acid in the Coolcrete solution opens the surface of the concrete and then the water causes the "rusting" re-action. This re-action begins immediately but can continue to develop for up to a month. There are other factors that can determine the outcome of the colour.

- Age of the cement
- Moisture content of the cement
- Type of aggregate in cement
 - siliceous aggregates such as gravel do not re-act with the stain. Floated, power floated or trowelled finish
- Weather conditions during stain application
- Efflorescence
- Preparation method before stain application. (13115)

Foamed concrete is also known as Cellular Lightweight Concrete (CLC). To make foamed concrete, special foam is blended into a mixture of sand, cement, fly ash and water. The quantities of these ingredients can be adjusted depending upon the application, balancing performance and cost. Foamed concrete can be placed easily by pouring or pumping and does not require compaction, vibration or leveling. It is possible to make foamed concrete in different size batches depending upon the application.

Advantages

- There are many benefits for using foamed concrete.
- Does not settle, hence requires no compaction
- Lightweight, does not impose large loadings
- Free flowing, spreads to fill all voids
- Excellent load spreading characteristics
- Once placed requires no maintenance

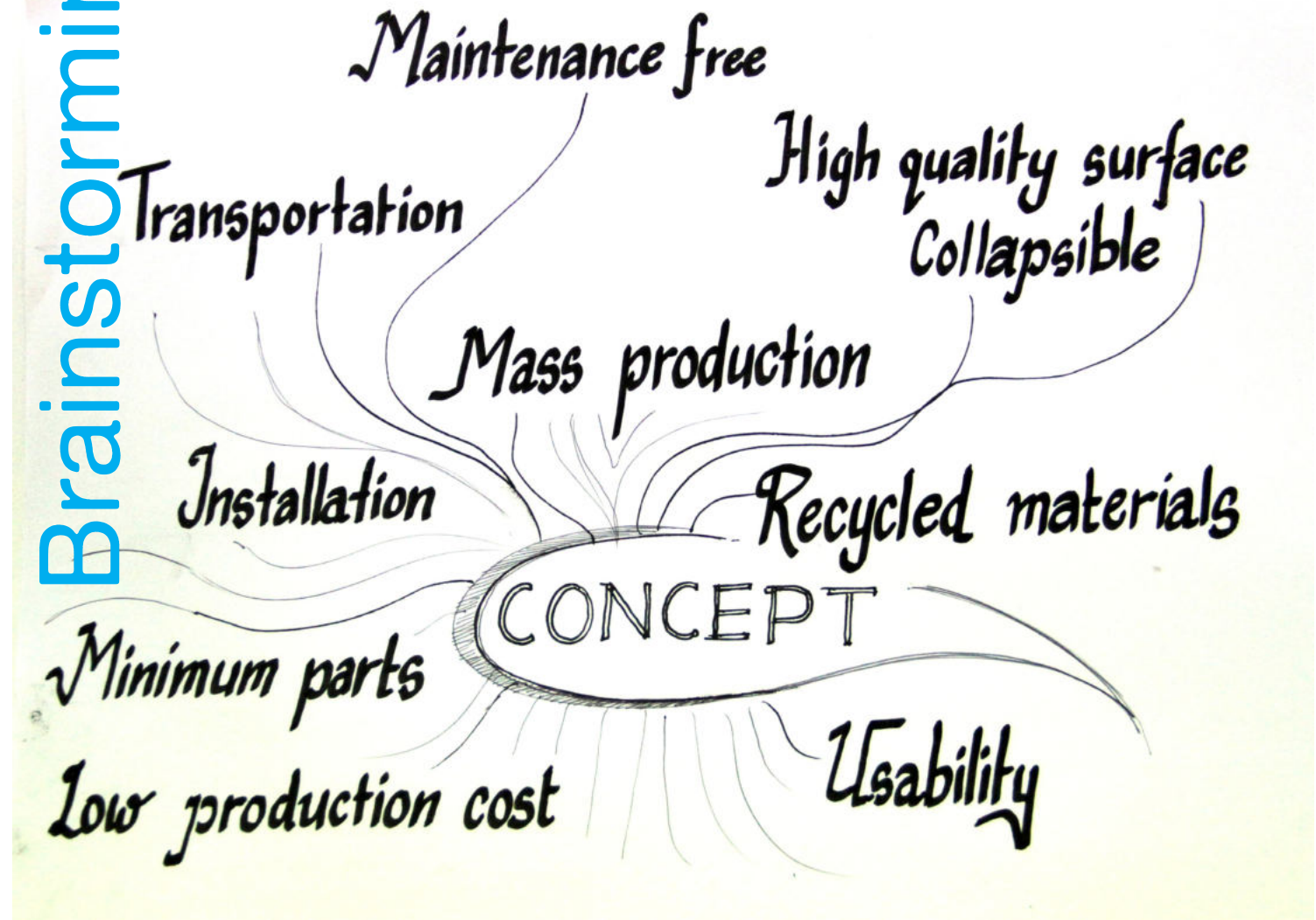
- Excellent sound and thermal insulation
- Excellent resistance to freeze-thaw cycle
- Does not impose lateral loads
- Low water absorption over time
- Excellent fire resistant properties
- Highly cost effective
- Non-hazardous
- Reliable quality control, so batches are easy to reproduce. (Foam concrete n.d.)



Fig.31 Foamed concrete

Fig.31 <http://4.bp.blogspot.com/-08rsFkByEBM/Ue0ABfKBHdI/AAAAAAAAASQ/5PGA3gAMQr0/s1600/7.jpg>

Brainstorming



Ideation

Pain areas

Pain Areas	Problems
Tieing reinforcement	Tieing reinforcement bars take lot of time and it also engages high amount labor
Plumbing systems	Putting pipes and connecting it takes lot of plumbers, and making a network for every unit delays time and increasing cost of purpose.
Electrical systems	Making of electrical network for a unit is time consuming.
Toilet fixture fitting	Assembling toilet fixture need high skill labor and it also need care for these fixtures which increases cost of unit.
Door window assembling	Assembling door window on site also take high skill carpenter and time and consume more power on site.
Flooring	Cutting and fixing each and every tile is a time consuming job, it also needs more tools and high skilled labor.

What can be product?



Fig.32

Floor treatment

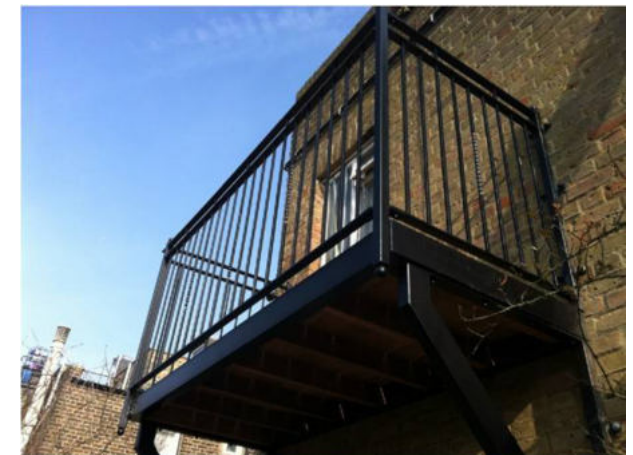


Fig.33

Modular balcony

Fig.33 i31<http://4.bp.blogspot.com/-Vs75nfivXwk/UIOBYQMiyII/AAAAAAAAAGpI/EodnrLHJ4NU/s1600/bedroom2.jpg>



Fig.34

Plumbing kit



Fig.35

Electrical kits



Fig.36

Reinforcement solutions



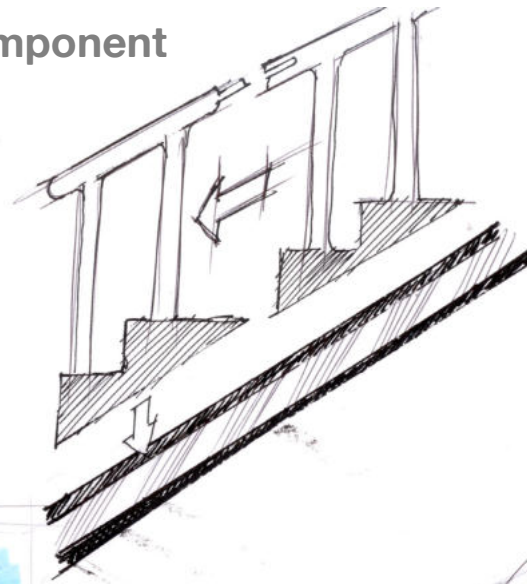
Fig.37

Staircase solution

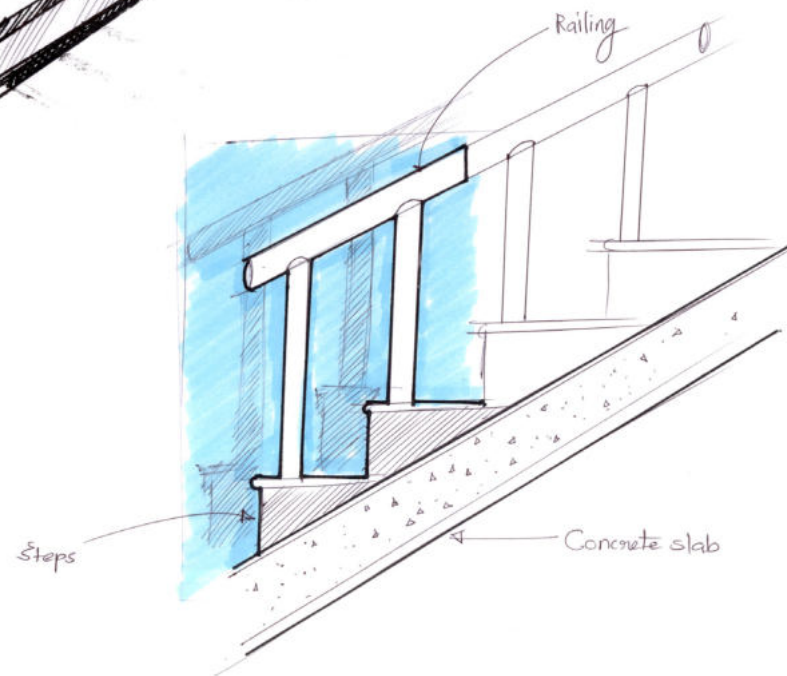
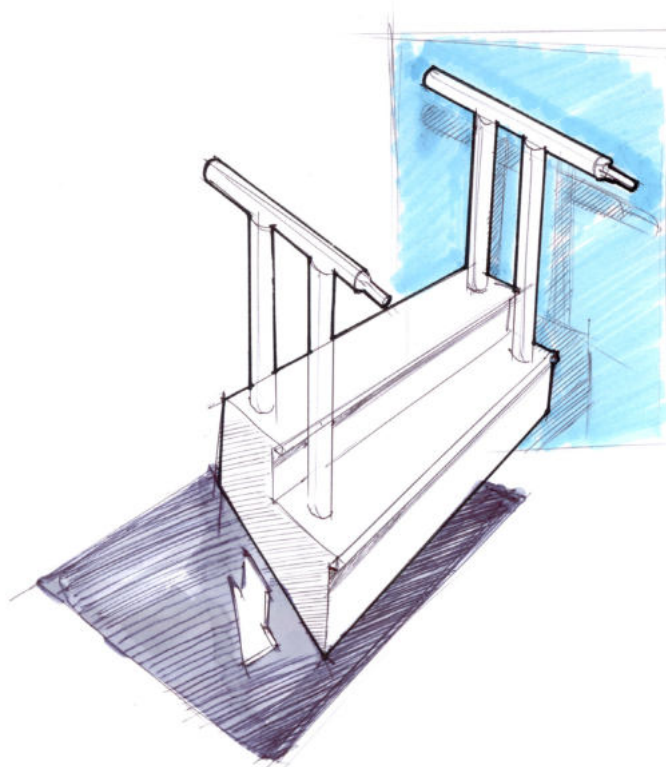
Concept

1 Staircase component

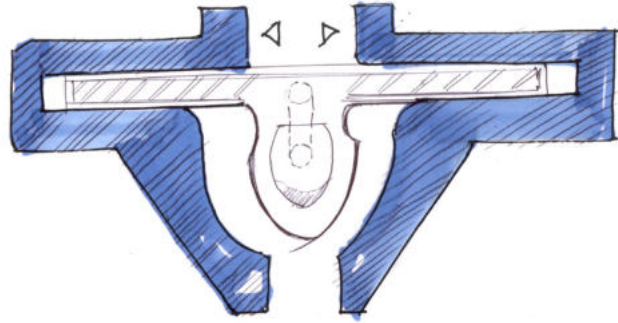
High quality **factory finished** surface.
Easy assembling.
Recycled material can be used.
Cut down **time** to get high quality finish.



- High quality finished surface.
- Easy assembling on site.
- Recycled material can be used.
- Cut down the time and need of High skilled labour to fix.



2 Integrated toilet unit



One shot molding.
Integrated piping system.
Save time of piping and assembling.
Direct assembly on site.

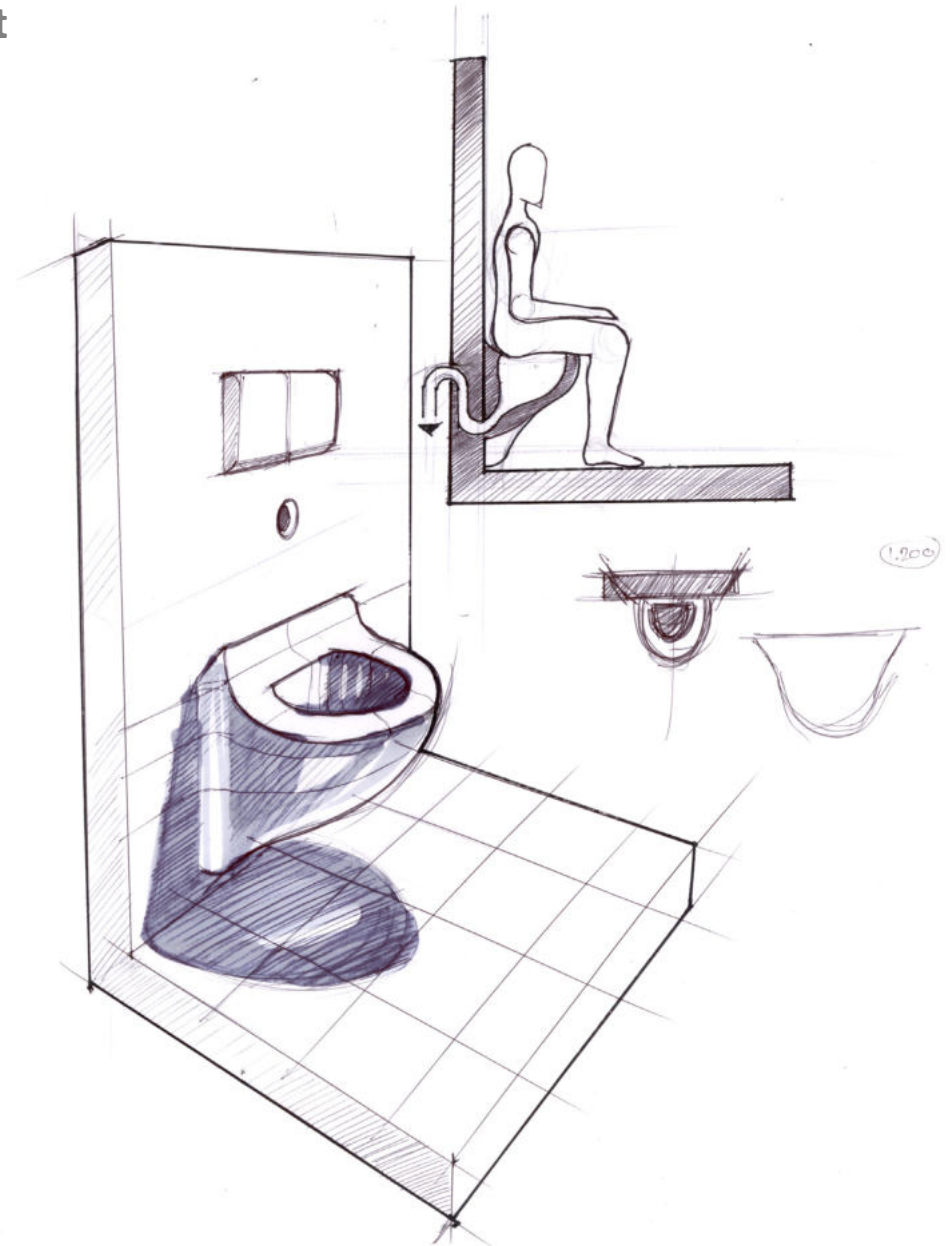




Fig.38

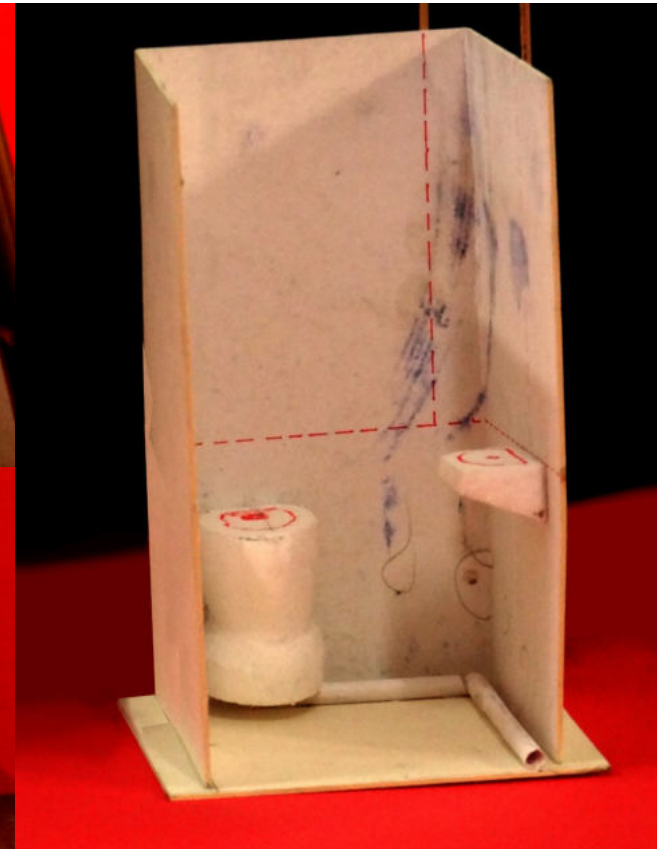
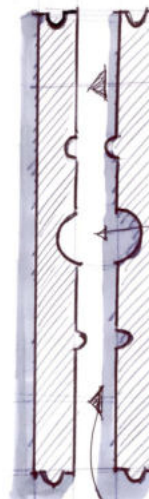
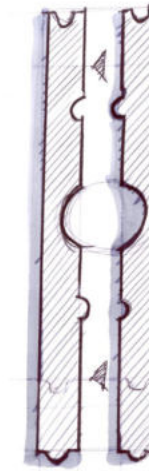
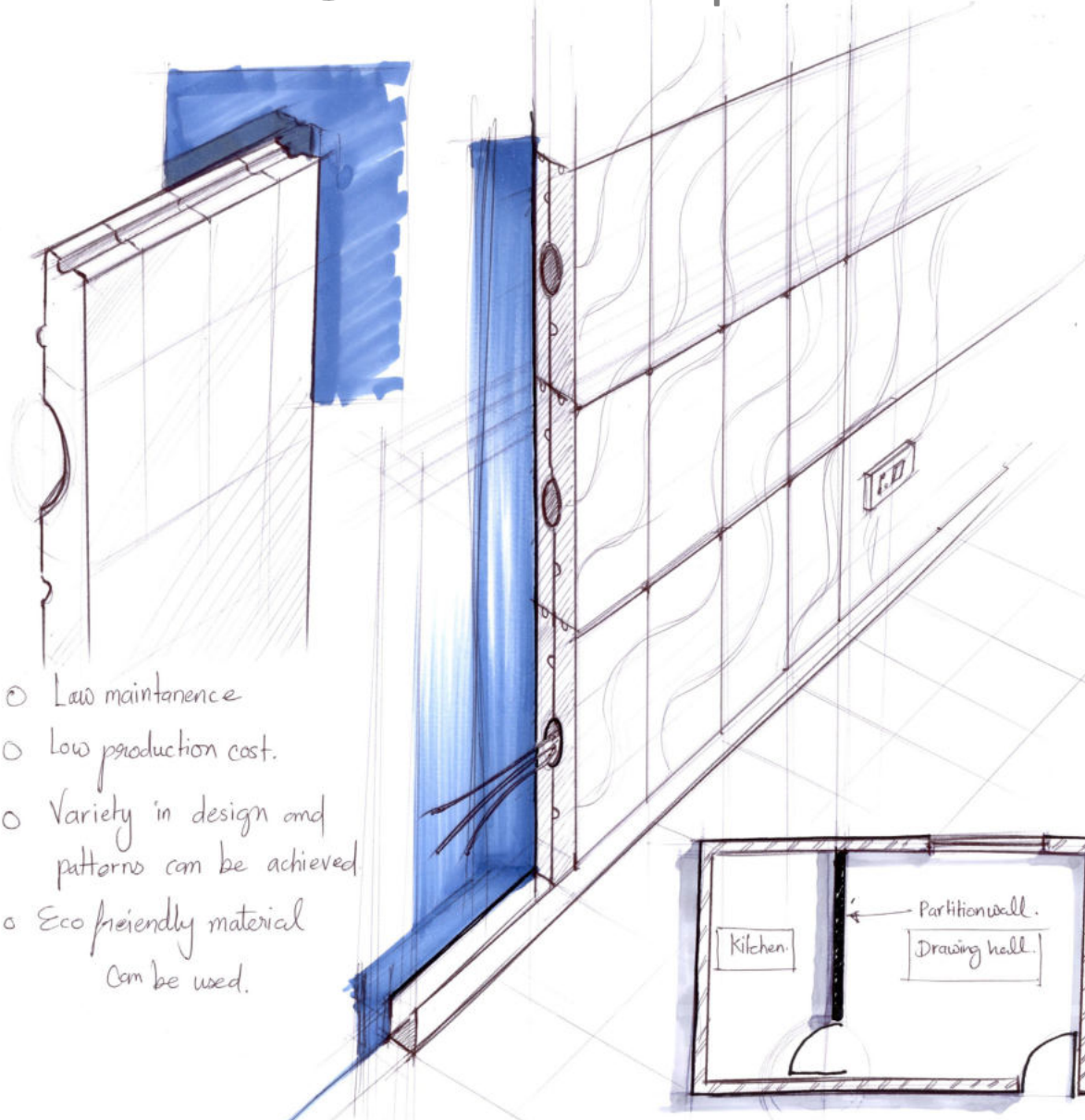


Fig.39 Integrated toilet unit mockup model

3 Partition wall component

- Low maintenance
- Low production cost.
- Variety in design and patterns can be achieved
- Eco friendly material can be used.



Low maintenance.

Variety in designs & patterns can be achieved
Can be act as a thermal mass.

Use of recycled material.
Integrated wiring grid.

Finished (Glass/Matt) Pattern.

Cavity
As a thermal mass
Can be used for wiring

Stick by solution.
or snapfit.

4 Ceiling cum shutter

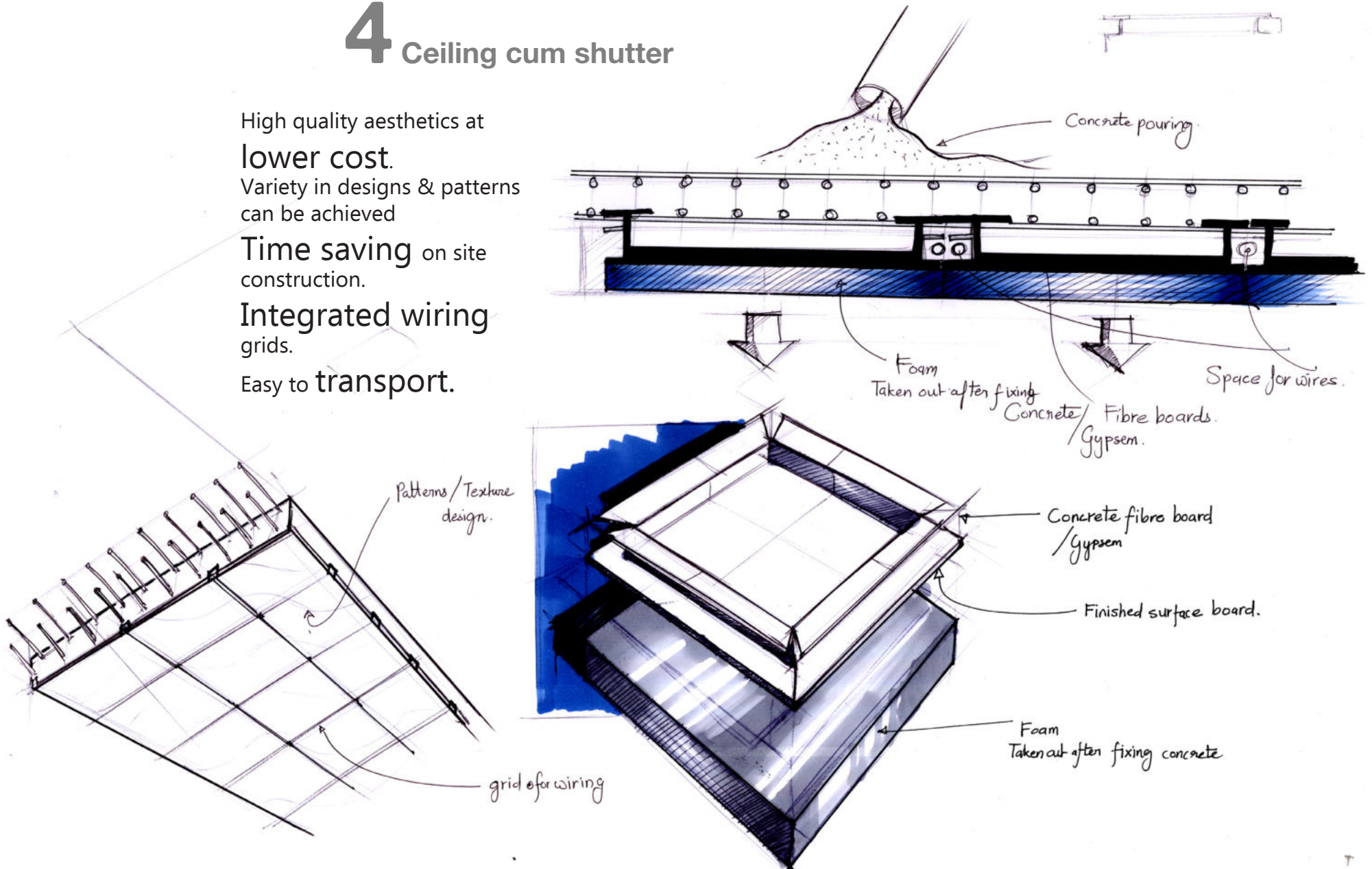
High quality aesthetics at
lower cost.

Variety in designs & patterns
can be achieved

Time saving on site
construction.

Integrated wiring
grids.

Easy to **transport.**



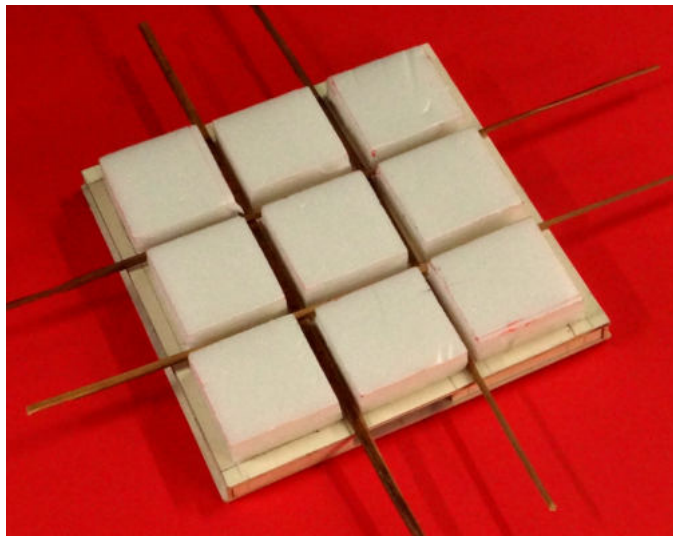


Fig.40 Ceiling cum shutter

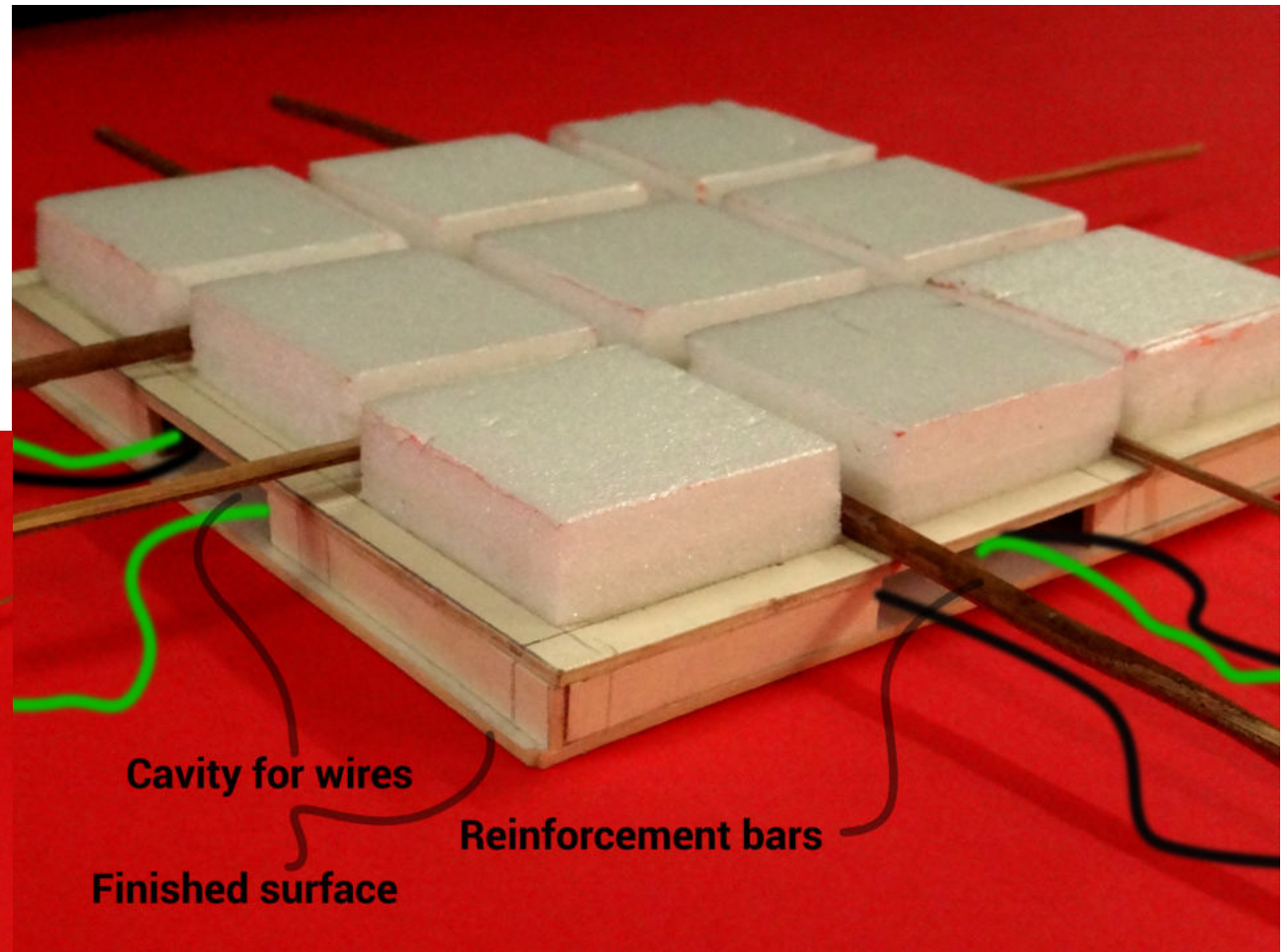


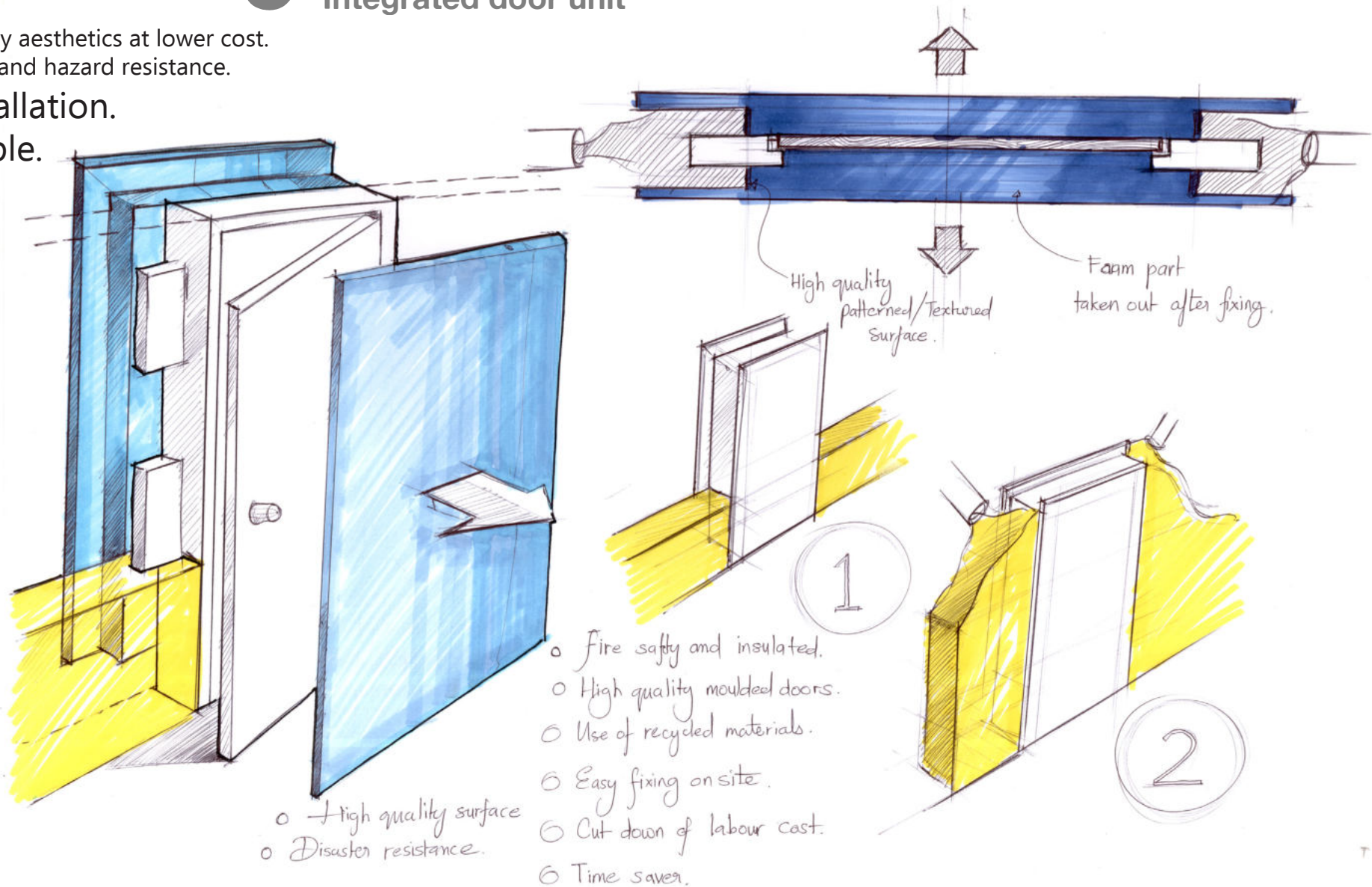
Fig.41 Ceiling cum shutter mockup model

5 Integrated door unit

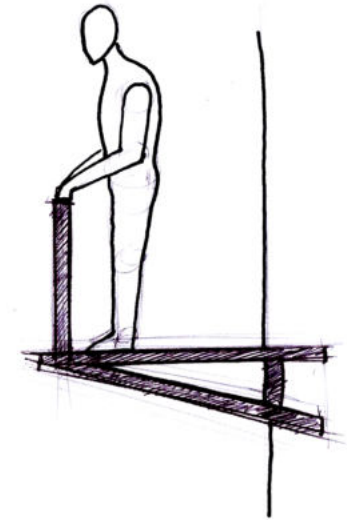
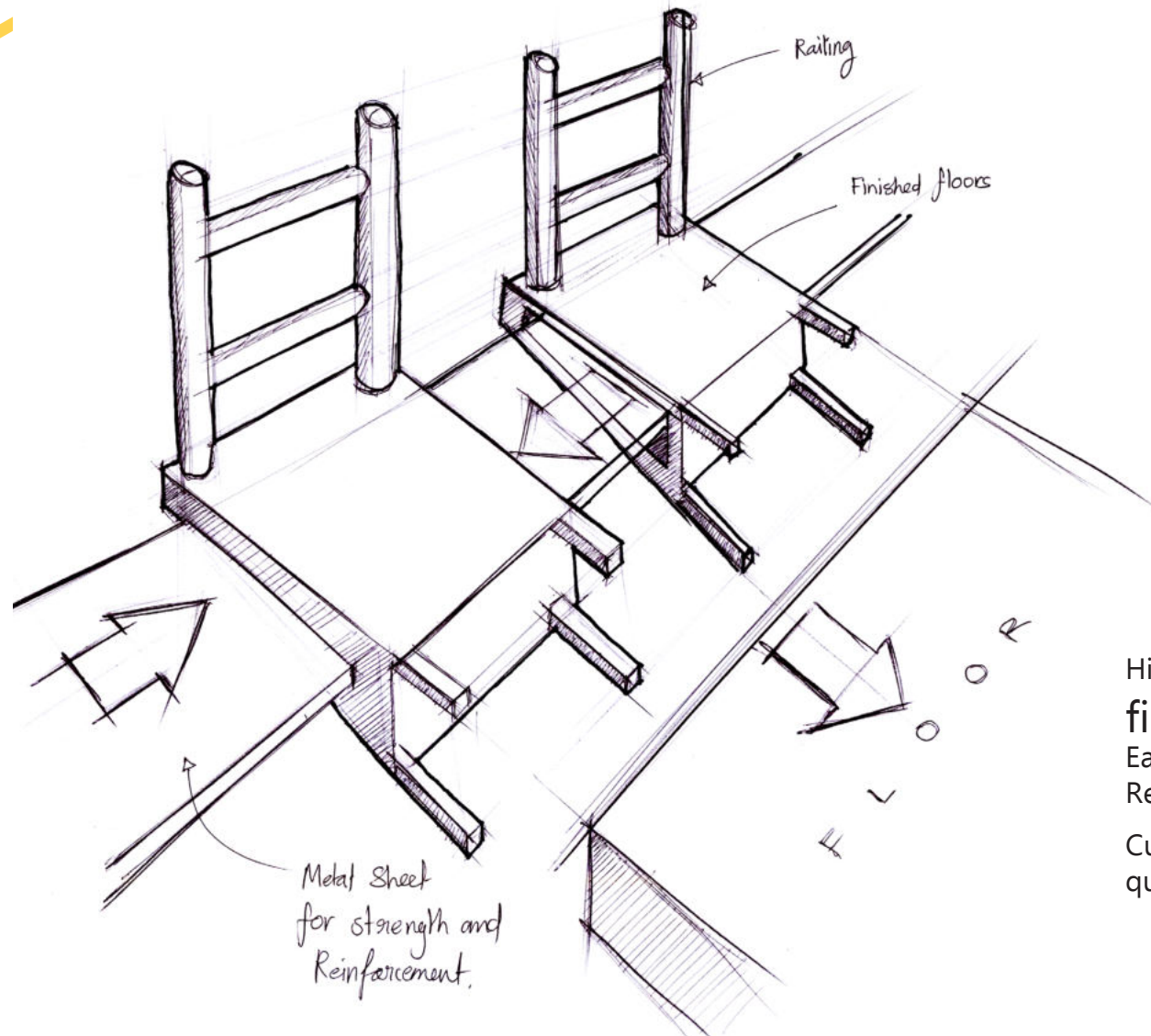
High quality aesthetics at lower cost.
Fire safety and hazard resistance.

Easy installation.

Stackeable.



6 Balcony component



High quality **factory finished** surface.
 Easy assembling.
 Recycled material can be used.
 Cut down **time** to get high quality finish.

7 Wiring layout (harness) system

Ready to use.

Concealed wiring network.

Maintenance free.

In built installation

Type of connectors. for shutter.

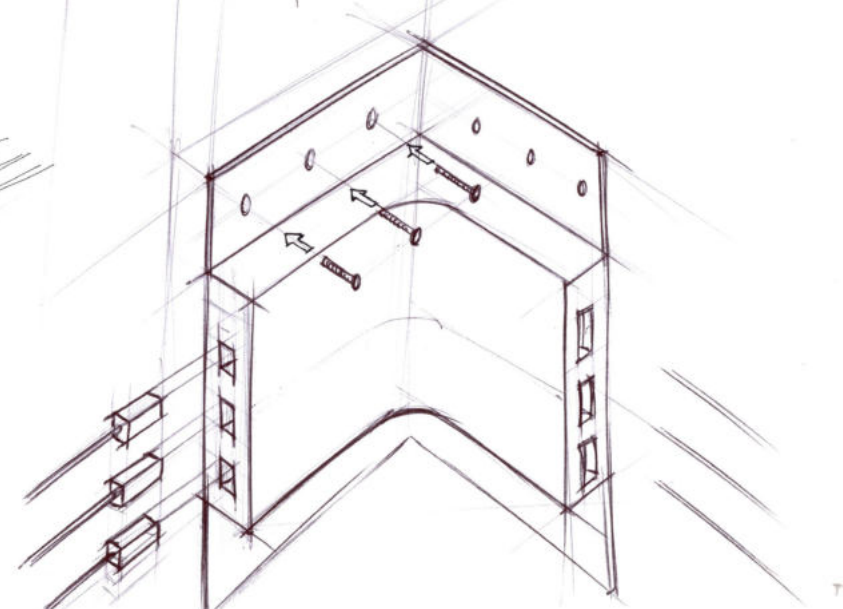
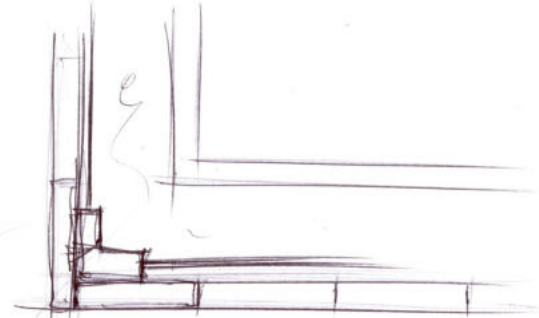
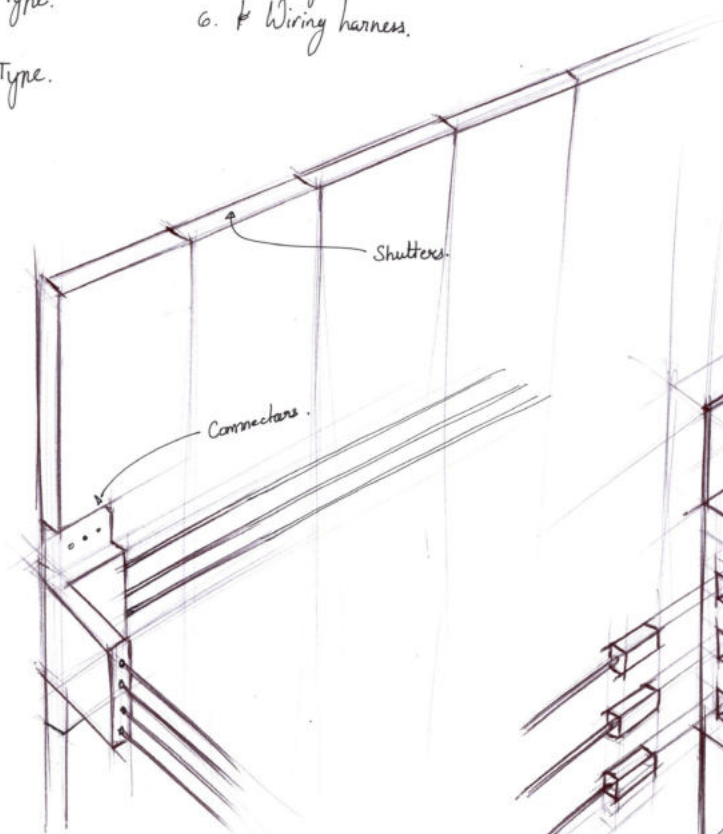
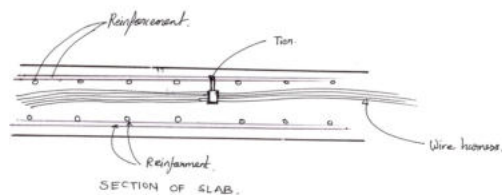
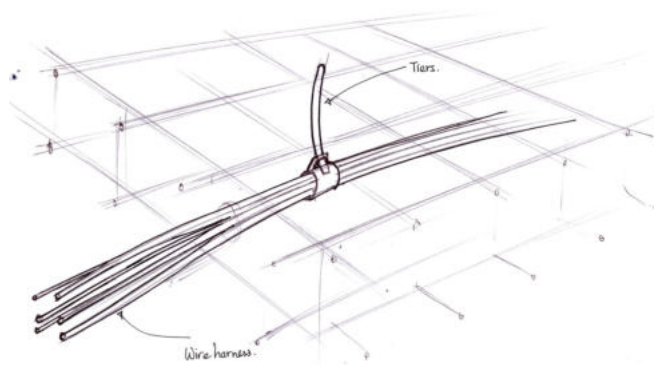
← Type.

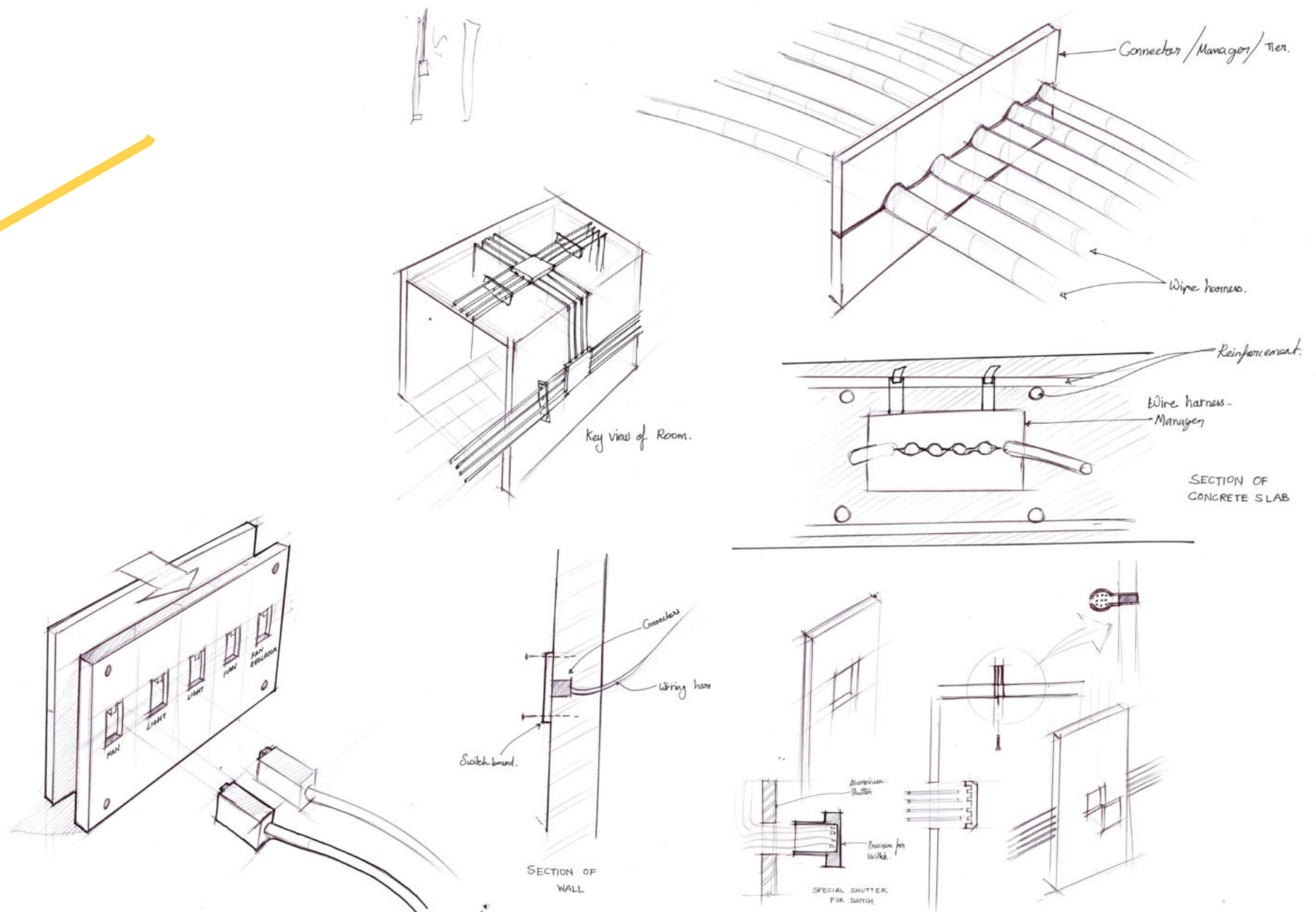
↑ Type.

← Type.

↓ Type.

1. Packaging of whole system
2. The whole thing incorporate in shutter.
3. P.V.C shrinkable sleeves.
4. How can we save wires.
5. Prototype.
6. & Wiring harness.

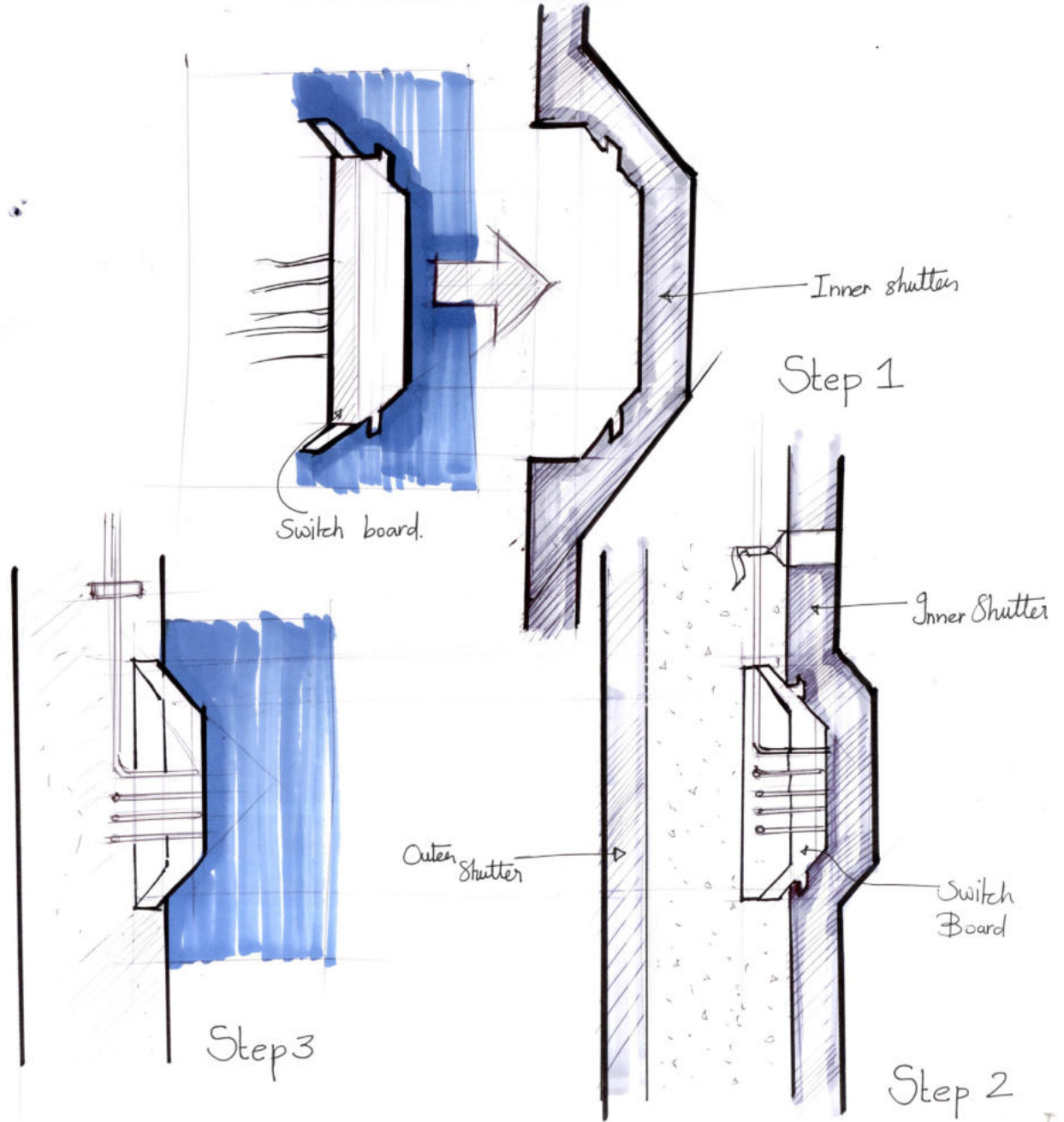
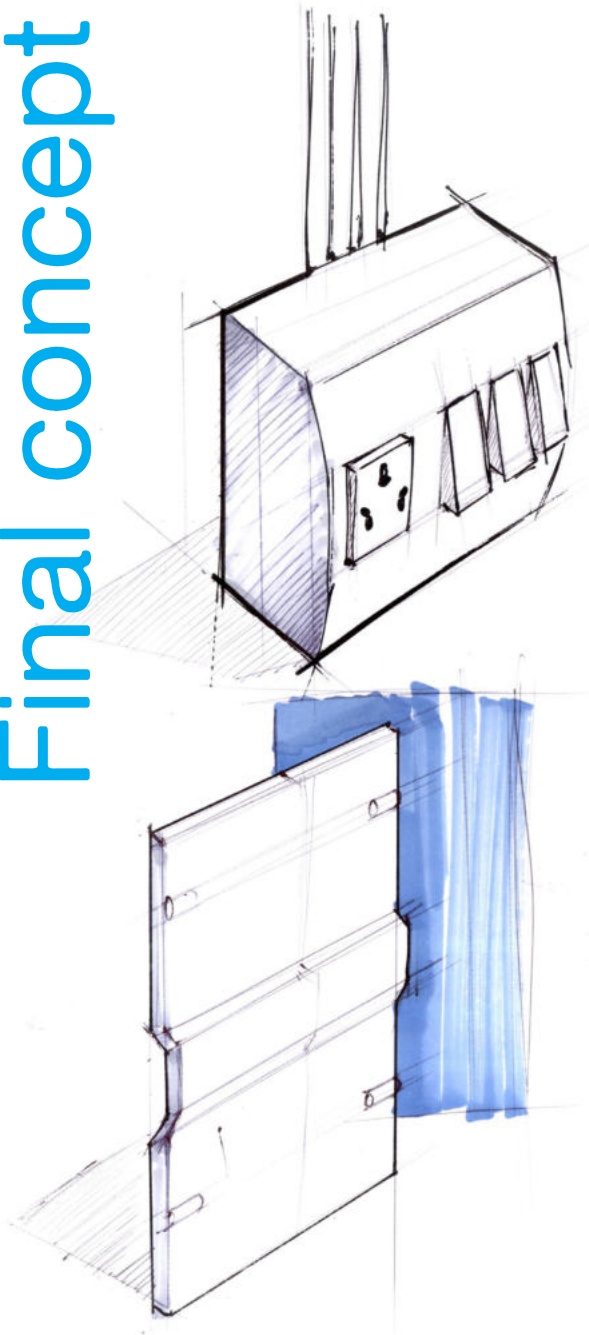


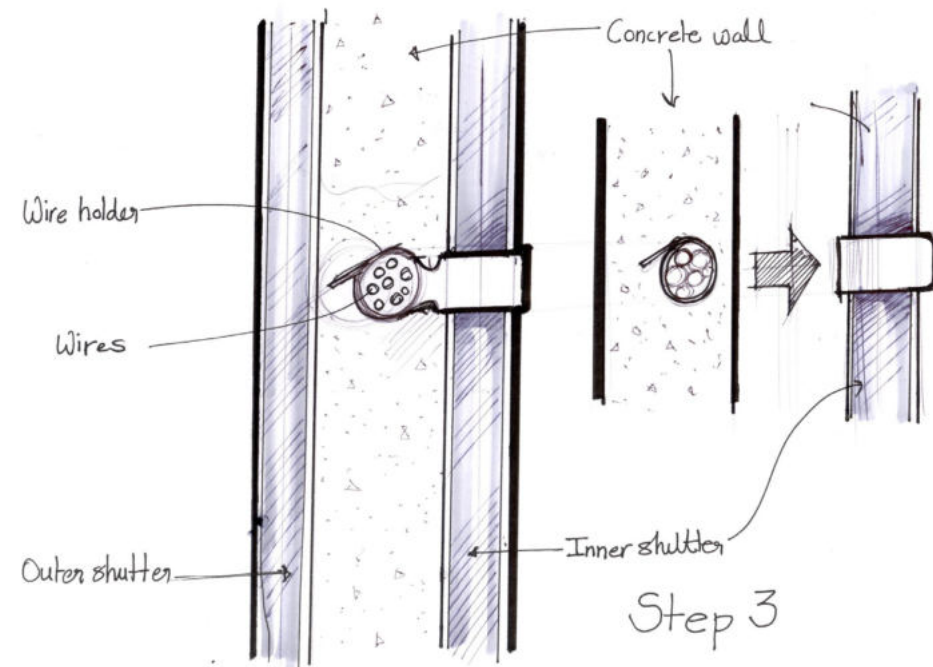
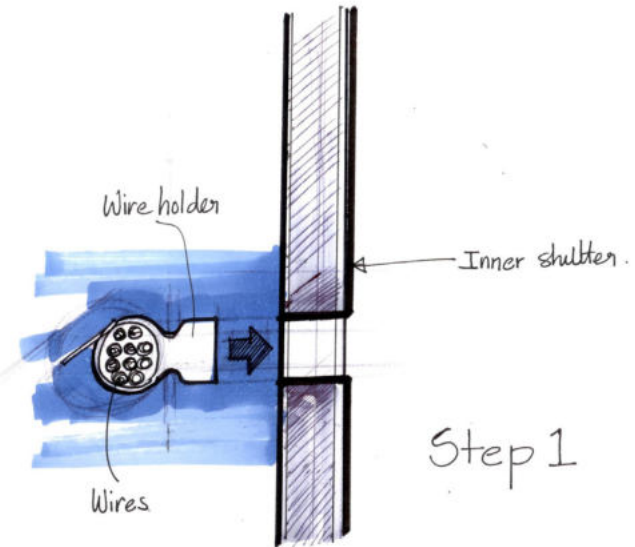
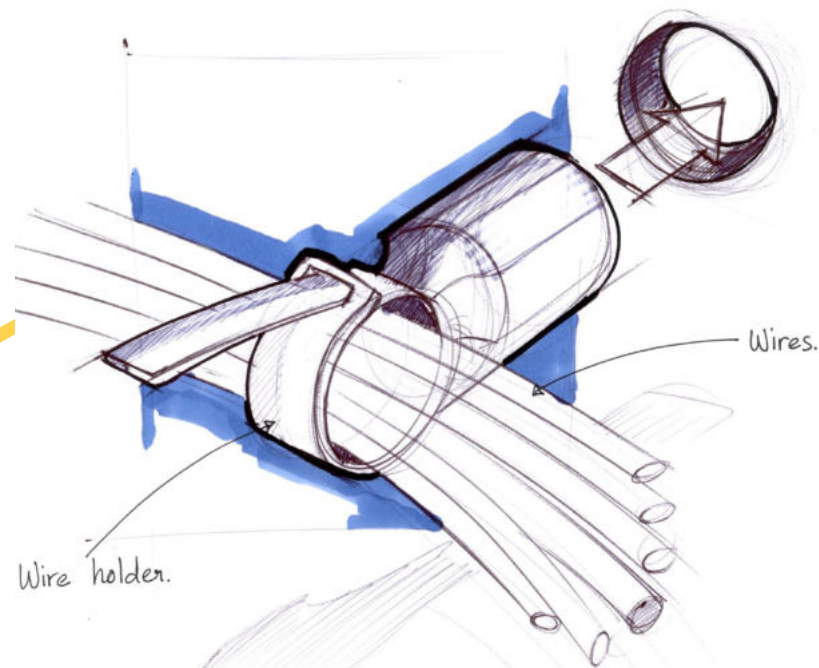


Concept evaluation

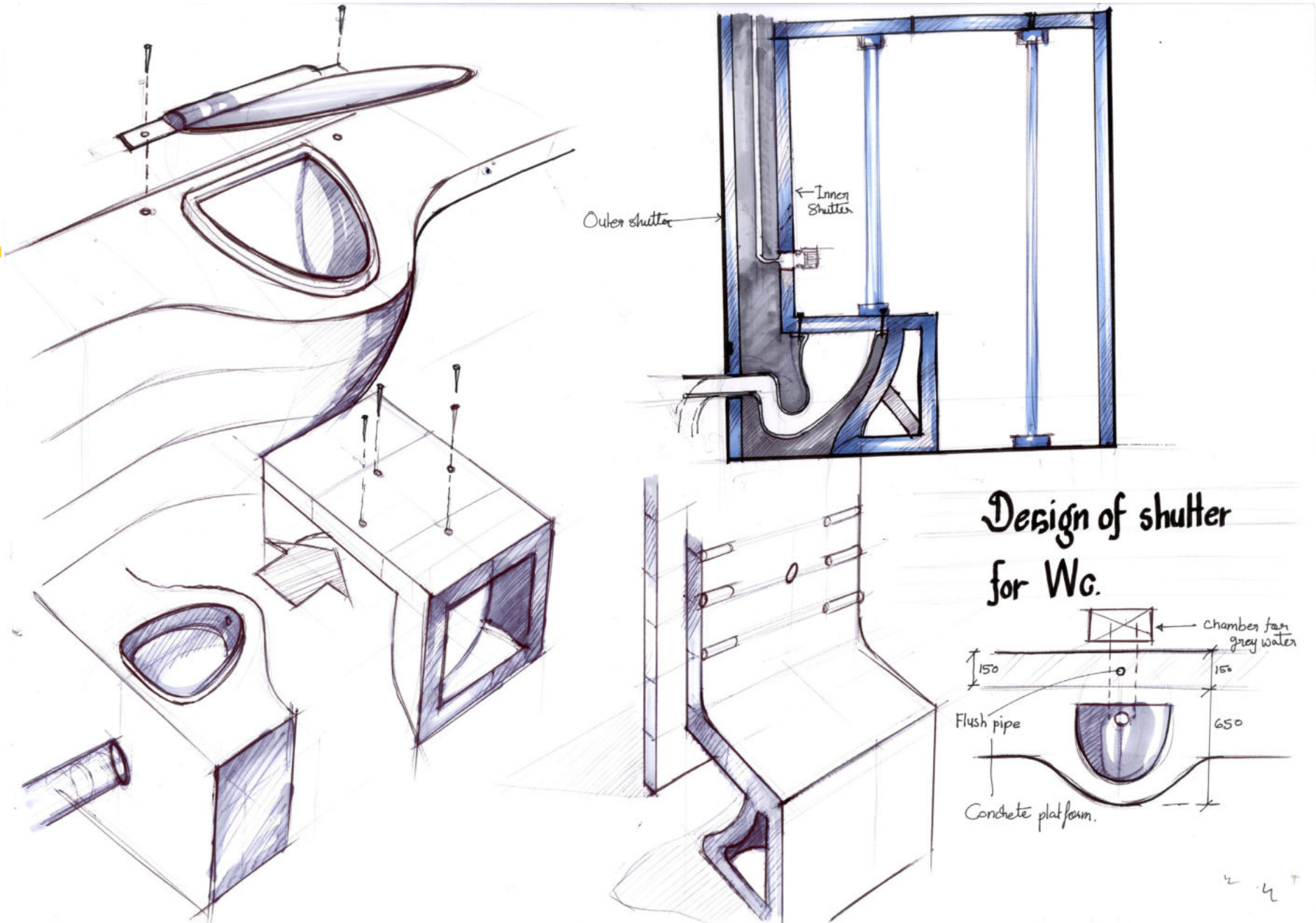
Concept evaluation								
		Time saving	Installation & usability	Transportation	Existing product	Surface finish	Production cost	Total
1	Stair case component	4	2	4	3	6	4	23
2	Integrated toilet unit	6	4	6	7	6	6	35
3	Partition wall component	4	4	6	2	6	7	29
4	Ceiling cum shutter	3	1	7	5	6	2	24
5	Integrated door unit	7	7	6	5	6	2	33
6	Balcony component	5	5	1	2	5	2	20
7	Electrical wiring (harness) network	7	5	6	6	6	5	35

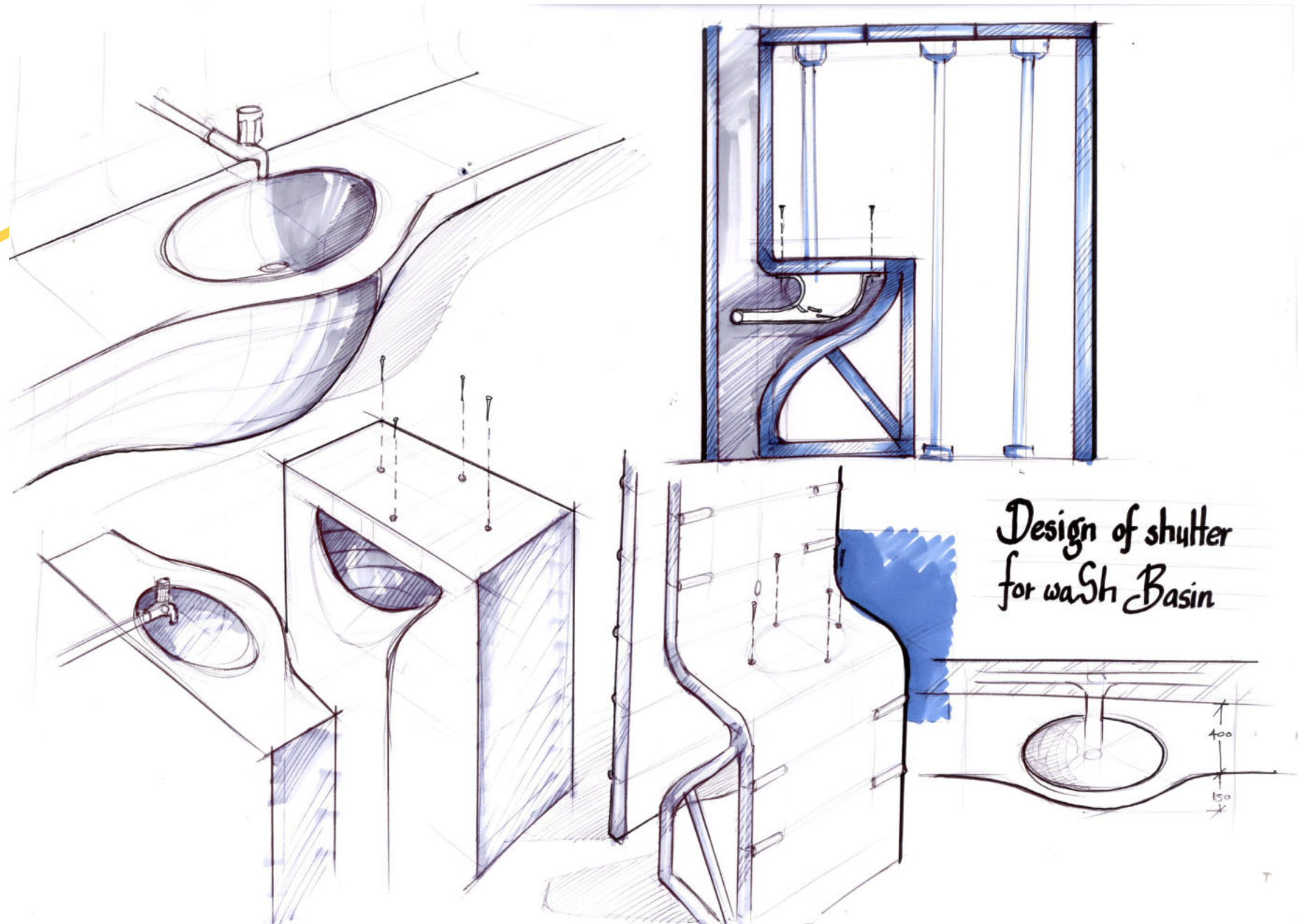
Final concept



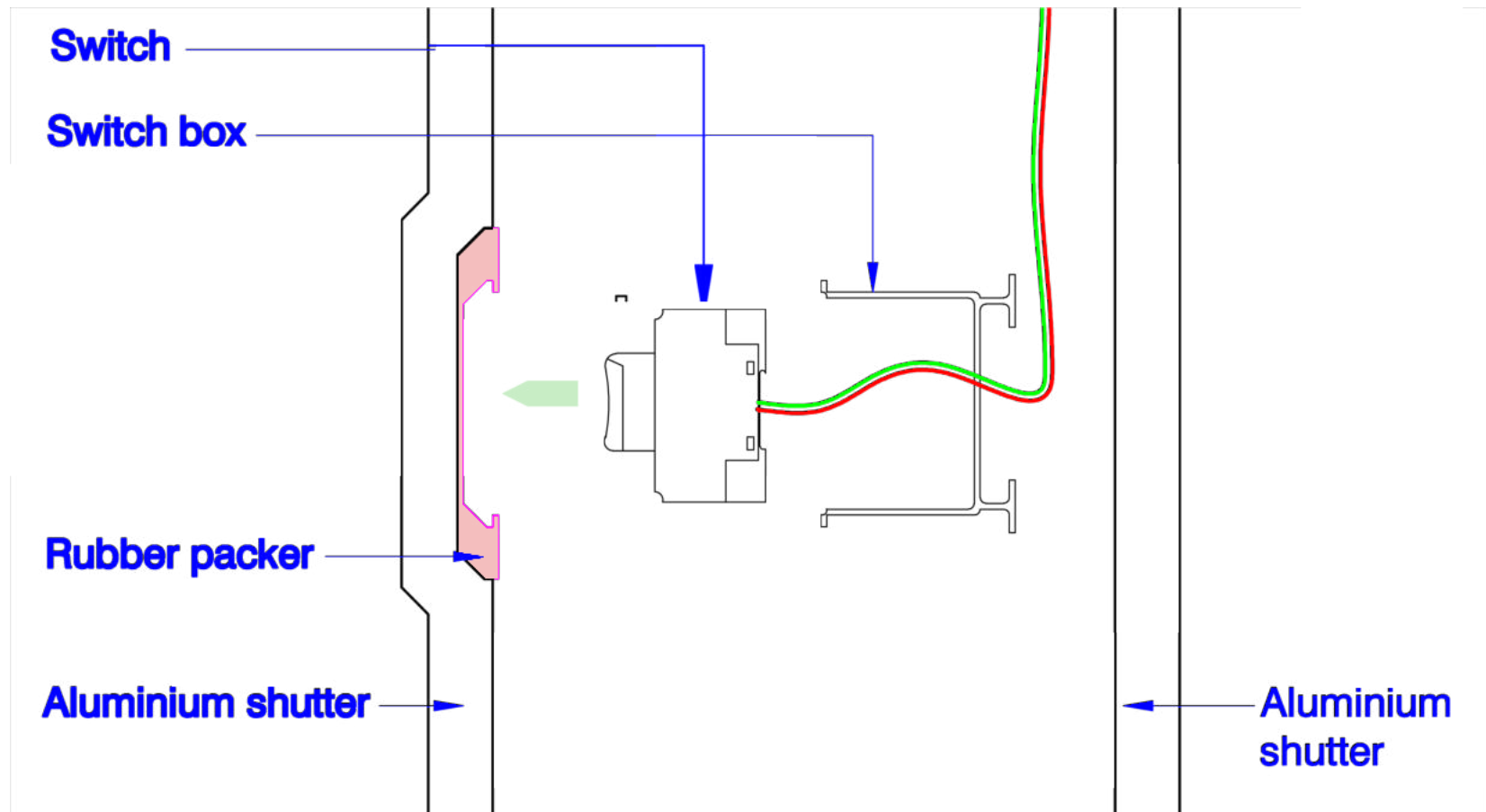


Step 2

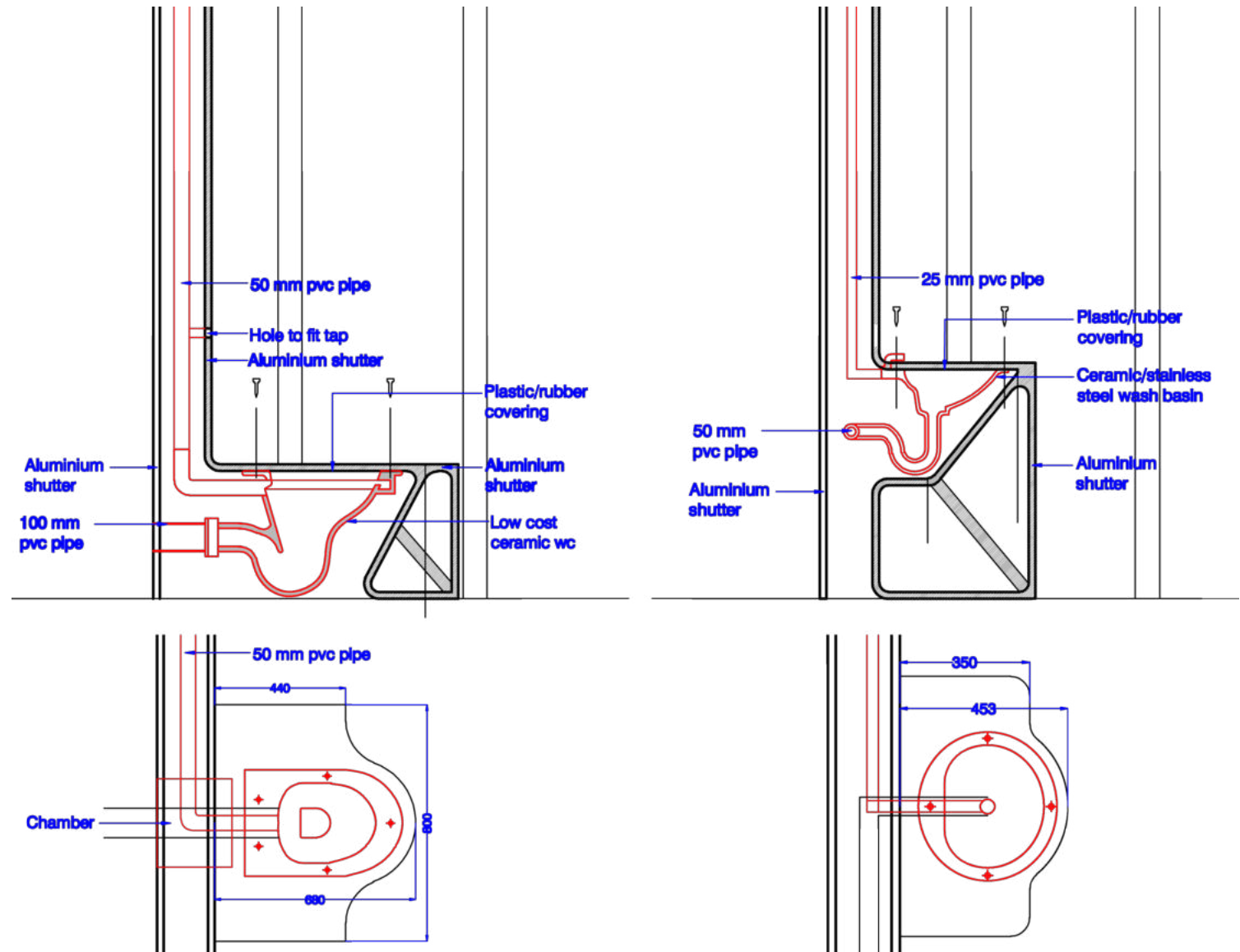




Wiring harness switch and shutter assembly



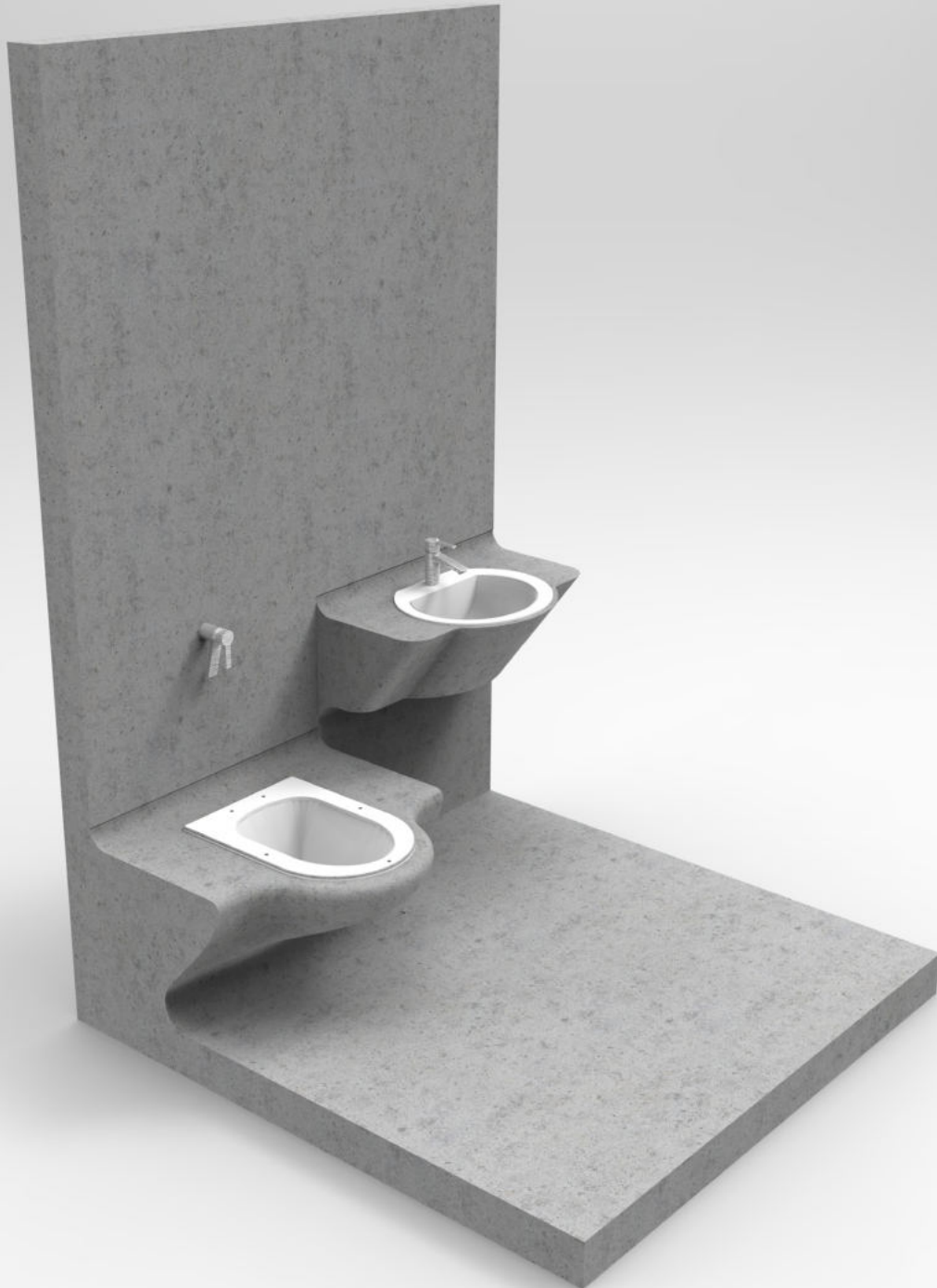
Section of shutters and process of integrated toilet unit



Process of fixing wc and shutter



Finished toilet



Check

Damage issue:

Sometimes damage happens after or before the process of construction is there any technique to avoid damage or resolve the damage with minimum effort.

Labor:

There is no control on labor behavior to the product sometimes they misuses components, which causes damage to the product.

Ceramic is preferable for making wc, but the problem with the ceramic is it is very fragile, So there is the possibility when concrete damages the pot. If any alternative material is there for making wc which can be Teflon coated HDPE or anything.

Extreme use of concrete in the design causes following:

1. More dead load to the structure.
2. Cost of construction is increased.

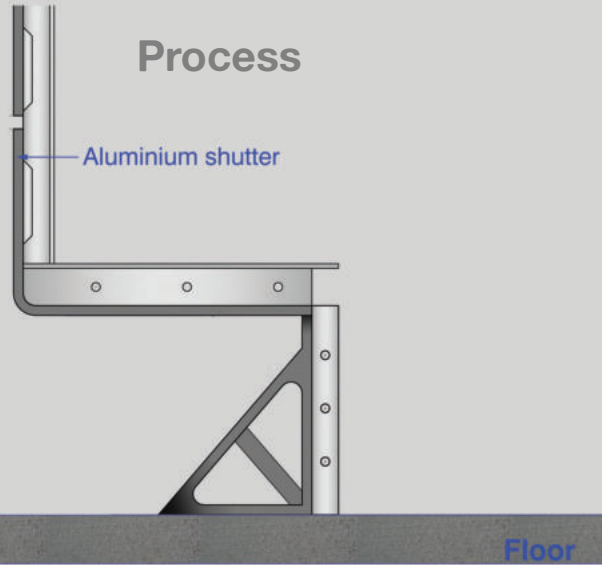
Design

1

Process

Aluminium shutter

When the process of reinforcement is done on site, then we can place aluminium shutter.

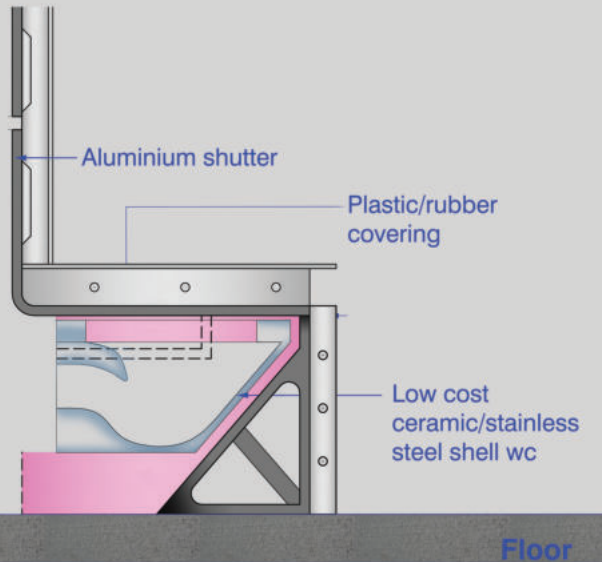


2

Aluminium shutter

Plastic/rubber covering

Assembling shutter with wc and packing it.



3

50 mm pvc pipe

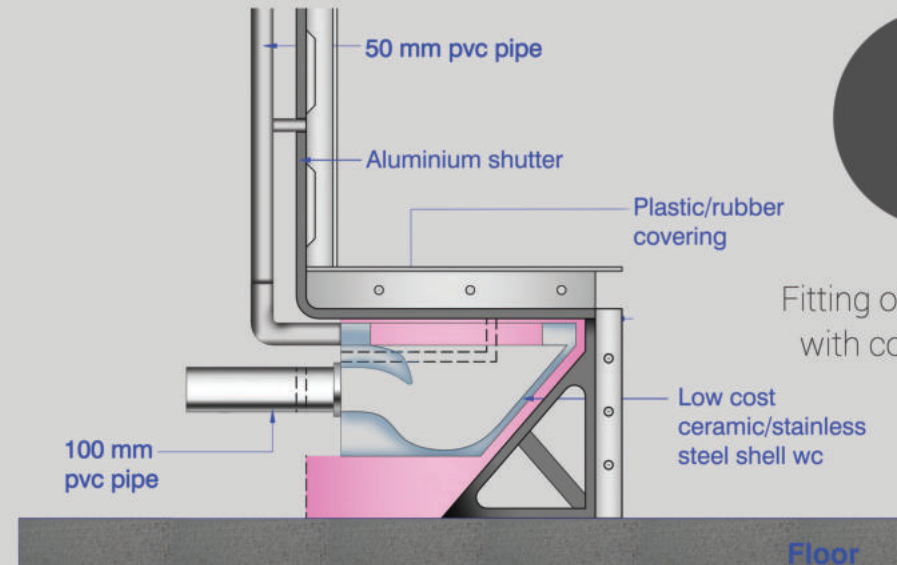
Aluminium shutter

Plastic/rubber covering

Fitting of pvc pipes with connections.

100 mm pvc pipe

Low cost ceramic/stainless steel shell wc



4

50 mm pvc pipe

Hole to fit tap

Aluminium shutter

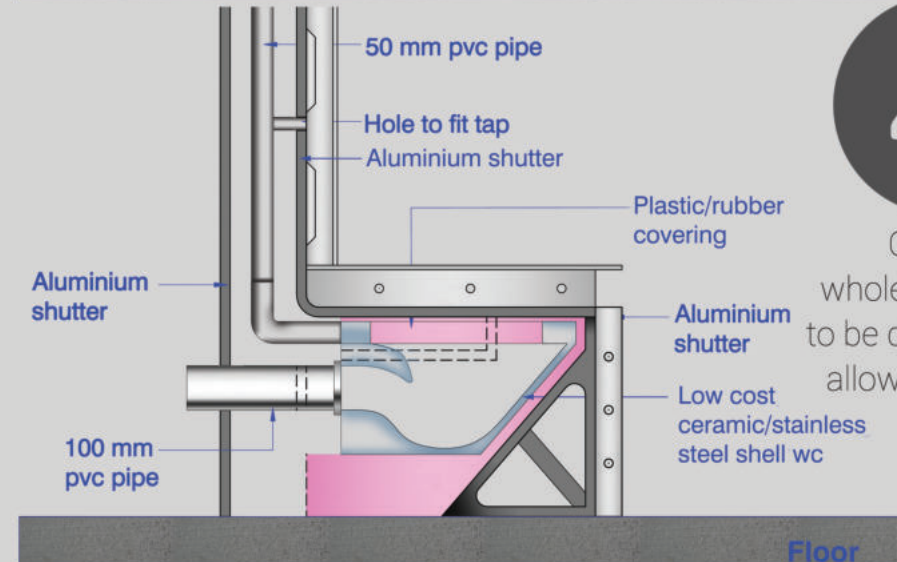
Plastic/rubber covering

Covering of whole system is to be done which allows concrete to pour.

Aluminium shutter

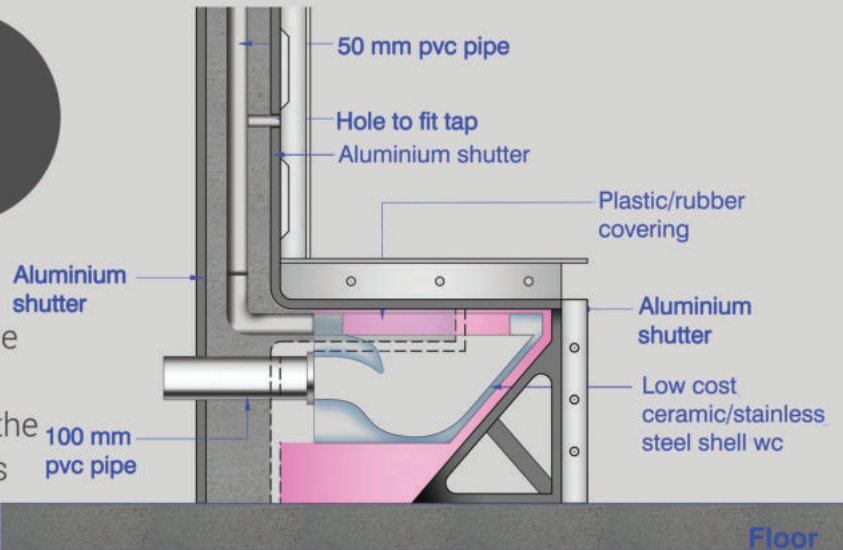
100 mm pvc pipe

Low cost ceramic/stainless steel shell wc



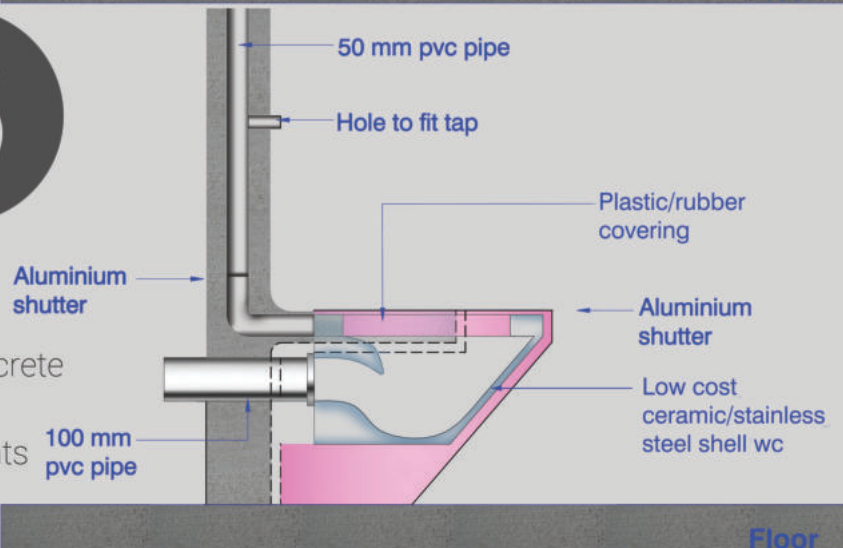
5

5. When the system is complete the concrete is poured.



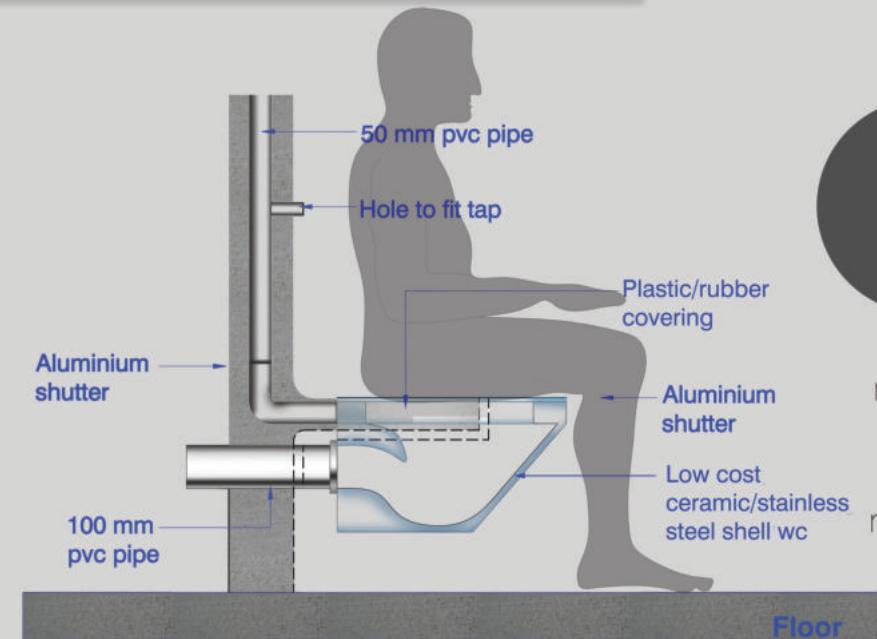
6

When concrete is set the components taken out.



7

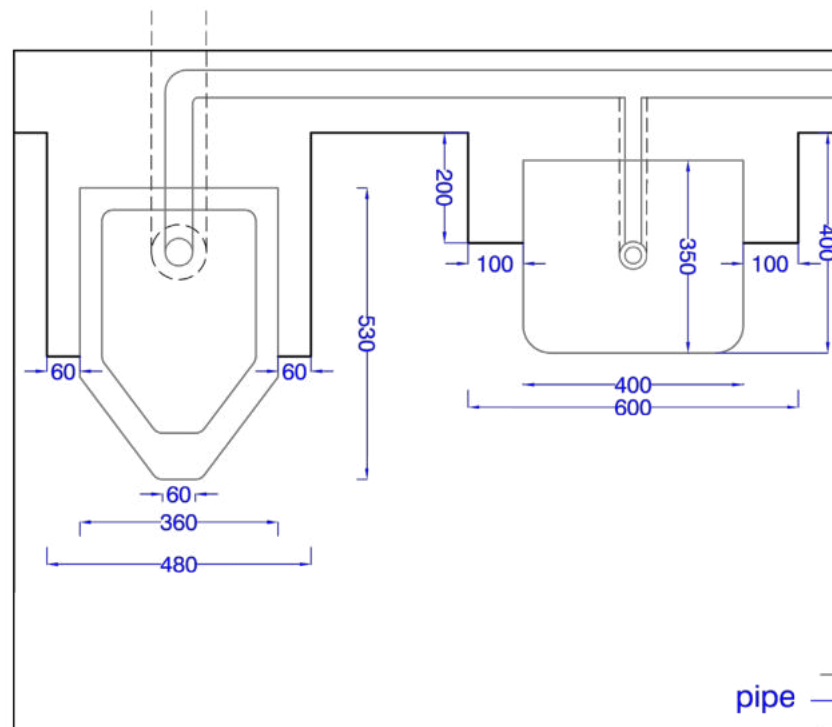
Applying resin/ tiles/ or acrylic finishing material for external finishing.



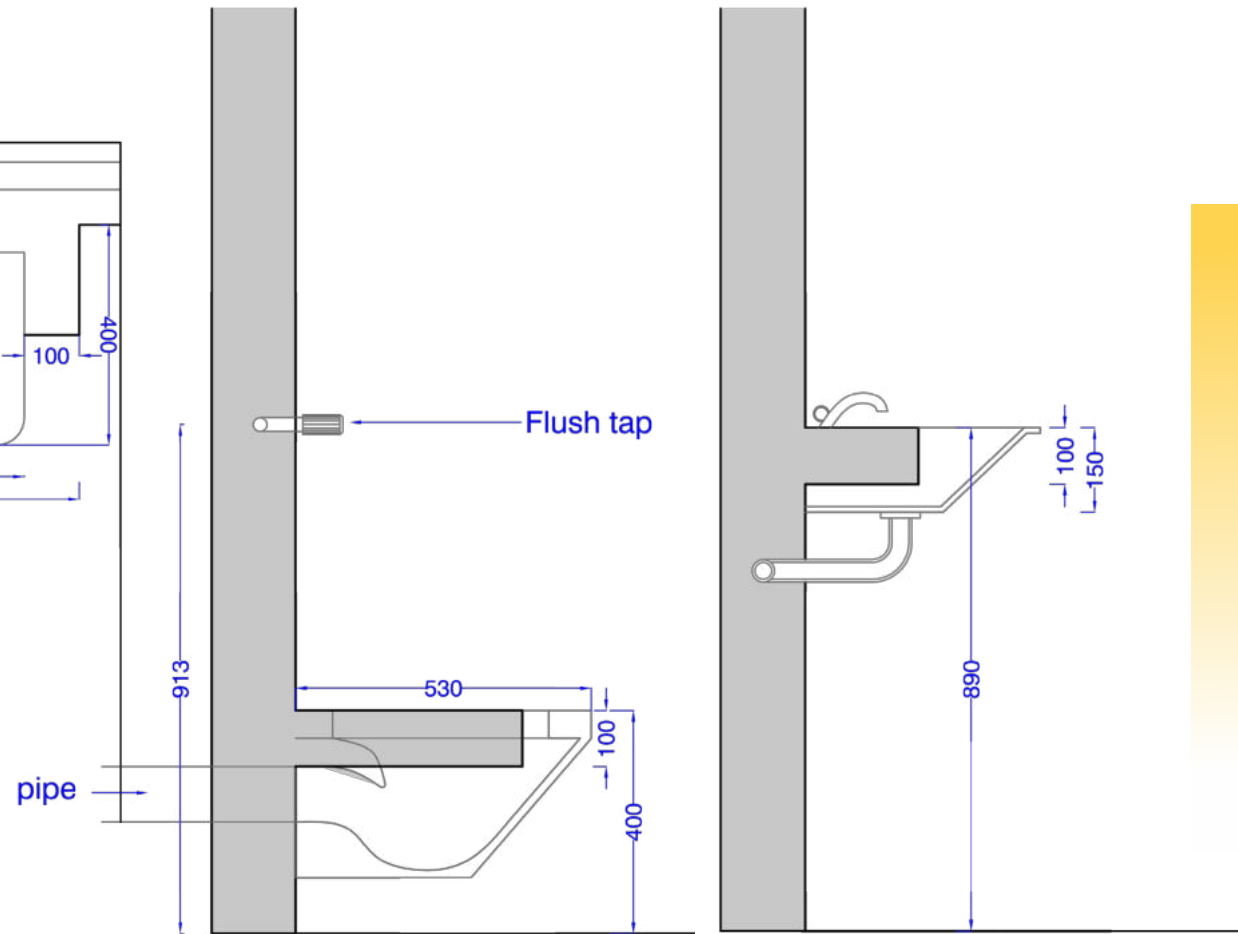
Mass Produced Toilets

Mass produced toilets is the process of making toilets in large quantities for making typical designed units. By considering formwork technique as a benchmark system this product has been developed. In this technique we have components which can assembled on site and make a set after pouring concrete we can get toilet ready.

Dimensional Drawing



PLAN



SIDE VIEW

Floor level

Floor level



Design advantage

Elimination of some processes:

Due to this product many process following has been eliminated

1. Traditional brickwork system.
2. Plastering.
3. Drilling and making pipeline.
4. Fixing of Wc.

Labour Cost is reduced:

All the components and fixing can be done very quickly, and after pouring concrete the whole components sets in a very short time without any labor or maintenance. Since Construction time is reduced, and the system doesn't need any skillful labor job, so overall labor cost can be extracted by this system.

Faster manufacturing:

Organizing the construction process with inventory controls, power tools and equipment, and quality-control systems enables the factory crews to produce a home with greater efficiency than a handful of construction workers building in the field. This technique cause faster system of development.



Low cost:

Volume purchases and mass production of materials, which allows mass manufacturers to secure significant discounts.

Low maintenance:

By using high quality factory made components there will be

Surface finish:

Due to the factory made components and standard size

Less waste:

All the materials and the components are available with standard size and dimension, according to standard design; this will reduce the exaggeration of materials.

Ease of use:

The whole process including components having standard dimensions according to design, So there is no need to measure again and again by the vendors and it is also very easy to understand by the novice labour.



- Less waste: By working with standardized dimensions, modular manufacturers are better able to make optimal use of materials and avoid waste.
- The total actual cost is lower for higher quality.
- Plumbing, ventilation and electricity are in place and ready for site connection.
- Construction time is reduced.
- The strength of the structure is greater due to the modular design, which is self-supporting.

Scale model



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 VBHC. <http://www.vbhc.com/apartments-for-sale/buy-flats> (accessed 11 20, 2013).
 VBHC apartments. <http://www.vbhc.com/apartments-for-sale/flats-in-mumbai/1bhk-apartments-for-sale/specifications-a-amenities> (accessed 11 10, 2013).

Software used

Solid works 2010
 Keyshot 4
 Photoshop
 Indesign