

Smart Dharavi:

a city in many grounds

When reviewing existing bibliography about Dharavi, it is not unusual to find negative concepts like shanties, marginal settlements, and poor slums, oriented to disqualify it as habitat option. Dharavi is presented as an area without proper infrastructure to serve its residents.

However, the concept of quality of life that could be used to strengthen these epithets is based on individual subjective perceptions; and in the case of Dharavi may not reflect the satisfaction of people to their way of life that allows them great capabilities. This feeling, strongly influenced by the environment, society, culture, and value systems, is presented with great force by Dharavi and its urban organization that supports the close relationship between the place of habitation and work.

“A unique characteristic of Dharavi is its **very close work-place relationship**. Productive activity takes place in nearly every home. As a result, Dharavi's economic activity is decentralized, human scale, home-based, low-tech and labor-intensive. This has created an organic and incrementally developing urban form that is pedestrianized, community-centric, and network-based, with mixed use, high density low-rise streetscapes. This is a model many planners have been trying to recreate in cities across the world. A simplistic re-zoning and segregating of these activities -- common in the United States -- would certainly hurt this very unique urban form”.⁽¹⁾

In fact, this home-work relationship has developed social and urban connections, that represent community-based successes, establishing desired parameters for all cities and therefore for their planners. The views expressed by Prakash M. Apte are important urban values that should be evaluated and preserved. An urbanism supported in the integration of functions and people, using urban elements not like puzzle pieces but as **living parts of a distinct organism**.

“**The street is the primary space of experience** in a city like Bombay (Mumbai). Not just thoroughfares connecting one place to another, Bombay streets are the quintessential space of the social”⁽²⁾

"The idea of a **staircase** that only serves for moving, a window that only gives light and ventilation, or a roof only offering shelter from the weather, is alien to our culture and cannot meet the diverse needs of different groups. A staircase can be used for various things: a place to sit or, if large, perhaps to sleep." ⁽³⁾

Facing this, Dharavi, heart of Mumbai, offers opportunity to tighten the house-work relation, reconciling densities with human relations, social organization and culture with amenities and infrastructure. Its nature must be preserved and repeated as example. A Dharavi with adequate infrastructure in which the dwellers won't be resettled in cubbyholes detached from the soil that has sustained their livelihood, and that now should become **a sustainable urban ground**.



http://issuu.com/wisdomseeker/docs/thesis_2010_dharavi_jv_arrenborg

(1) Prakash M. Apte (2008-09-29), Dharavi: India's Model Slum.

(2) Zitzewitz, Karin (2009), The Moral Economy of the Street. The Bombay Paintings of Gieve Patel and Sudhir Patwardhan. Third Text, 23:2, 151.

(3) Doshi, Balkrishna (1997), Social Institutions and a sense of place



Close work-house relationship



Livable streets



Productivity

What Dharavies cherish?



Strong Community ties



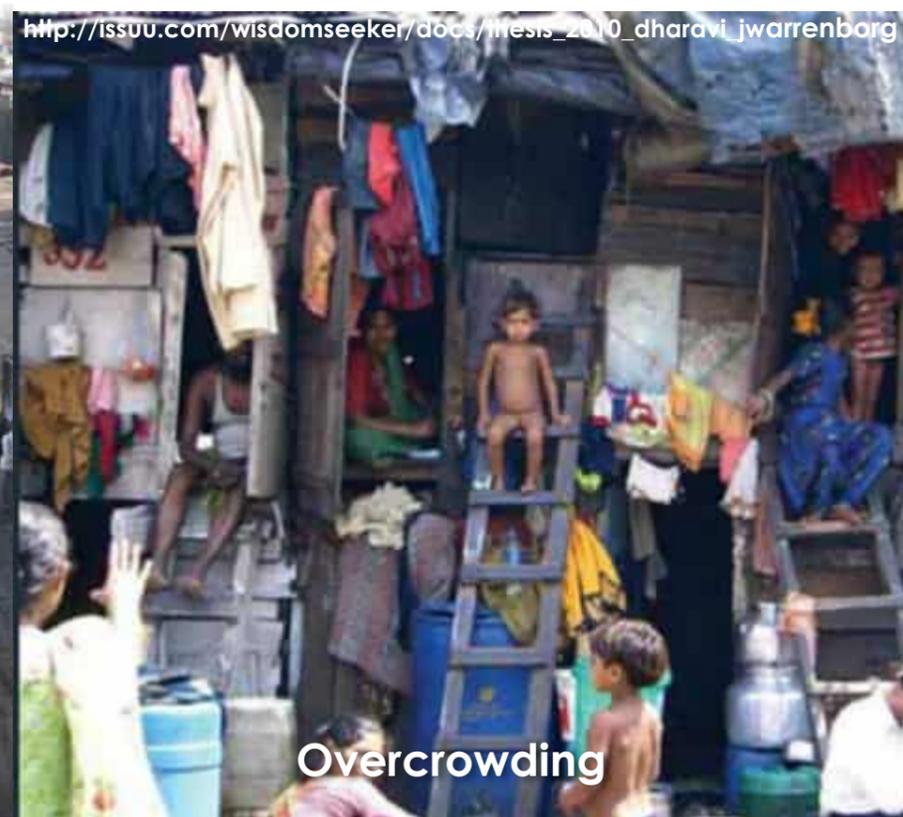
Good common toilets



Coexistence of beliefs



Poor urban services



Overcrowding



Non adequate buildings

Why is present Dharavi not sustainable, why is to be reinvented?



Insufficient sanitation



Flooding



Poor construction quality

http://blog-imgs-68-origin.fc2.com/n/e/w/newskvip/slums_08.jpg

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Mumbai is South Asia's biggest city.

Around half the population—of 14 million,—live in slums. Another 3 million commute daily from surrounding suburbs.

The slum policy was launched 1997, with the aim of redeveloping all of Mumbai's slums by 2007. It has resettled 500,000 slum-dwellers but 2 million new ones have arrived in the city since.

Airliners circle Mumbai awaiting space to land. One of the airport's two runways is inoperative, because 300,000 squatters have built shacks around it. The roads are even worse: Mumbai is traversed by two north-south highways, with no large axis between them. Every day an estimated 500 cars are added to the city's jams.

Mumbai is a city with ambitions to become an international financial hub. Building Mumbai's infrastructure anew is estimated by government of Maharashtra in \$60 billion a decade long. Central Government had earmarked \$9 billion for Maharashtra's urban infrastructure in 2007. The private sector would complete the rest.

“There is much at stake, for India as well as Mumbai. Its recent high economic growth is an urban phenomenon. Huge improvements in urban infrastructure are needed urgently if it is to be sustained” (1)



Many factors are **blocking urban development**, and **Dharavi is a sample** of it, with 3 decades of debate over its improvement.

Mumbai needs a winning round against informality as necessary step to become the financial capital of India. It has to write the first chapter in a quest towards development and this chapter could be learned with Dharavi.

(1) <http://www.economist.com/node/9724333>

(2) MUMBAI DHARAVI - SCENARIOS FOR DEVELOPMENT Columbia University Graduate School of Architecture, Planning and Preservation Final Paper Master in Architecture and Urban Design Spring 2009

Facing urban design in informal areas or city center, requires size and population facts, to support dimensioning of all urban components. The concept of density inhabitant per spatial unit is difficult to pin down in a place like Dharavi, where registers are not exact and surveys difficult to attain. Existing data points to a highly populated area but offers differences in total inhabitants.

The discrepancies are evident when comparing different references to the population of the area. For example, between 1986 and 2008 the population difference is less than 100 thousand inhabitants. By 1986 the SPARC-NSDF survey produced an estimate of 530,225 people, some 106,000 families living in 86,000 residential structures ⁽¹⁾, and for 2008 Prakash M. Apte, Urban Development Consultant, states that "Dharavi has a population of more than 600,000 people living in 100,000 makeshift homes, and one of the highest population densities in the world at over 12,000 persons per acre". ⁽²⁾ However numerous articles and blogs published on the website in relation to Dharavi report that **"a million people live here without hospitals, sewer or aqueduct"**. ⁽³⁾

"If the benefit of living in the city is the density of human relationships set forth and the problem arises when considering the place of living, especially for people with fewer resources, the question immediately arises: **How do high densities reconcile with sustainable urban life?**" ⁽⁴⁾

Based on this, we venture to conclude that regardless of the exact number of inhabitants Dharavi has, what is important is to work on these places to live, i.e., housing and relationships between them. In this respect all authors agree on similar average numbers, therefore, using data from Professor Prakash M. Apte, to provide adequate quality of life for the residents of Dharavi we focus on the "construction of **100,000 apartments** existing for the residents". For although "some consider "Dharavi slum as an embarrassing eyesore in the heart of the financial capital of India, its residents consider it home."

City	People/Ha	MM
Dharavi	4,175.54	1.000
	2,505.32	0.600
Mumbai	114.48	14.35
New York	106.30	8.41
San Francisco	66.33	0.805
Shangai	51.74	0.645
Boston	49.39	14.3
Delhi	42.66	10
Baghdag	35.71	5.5

?



(1) Weinstein, Liza (2014-04-01). The Durable Slum: Dharavi and the Right to Stay Put in Globalizing Mumbai

(2) Prakash M. Apte (2008-09-29) Dharavi: India's Model Slum PDT by NATE BERG Community / Economic Development, Urban Development, India

(3)/(6) <http://elindochino.blogspot.com/2009/05/contraste-bangalore-y-dharavi.html>

(4) Sergio Román Aliste (2011), Doblado y desdoblado la trama urbana en la India contemporánea.

(5) Prakash M. Apte (2006), Dharavi Redevelopment: Hard Fact.

More than 60% of the Indian population has no option but to live in slums; they are generally on land reserved for public purpose.

In early 80's India began implementing the idea of **incentives to cross-subsidize** cost of slum redevelopment in search of city wide solutions. Town planning and participatory schemes **TPS PDS** emerged: [1]

- Land Compensation to People affected Projects PAP Land acquired, developed and returned to original owners.
- Participatory Development Scheme PDS, private sector undertaking large scale development in return for provision of social housing.
- Transferable Development Rights TDR tool for landowners affected by amenities plan transfer development-rights to other areas.
- Slum Redevelopment Scheme through incentives SRD, increase housing supply in high demand areas.
- An upper ceiling of max permitted construction is fixed on 2.5 times plot area and surplus construction rights can be sold as TDR in the market.

But since 1999 **results have been poor in Dharavi**. Demolishing parts of it to build higher structures, has not been a solution to the city or its dwellers. Around 1/3 of Dharavi has been intervened with 7 story buildings. Many of such a low quality in design, and infrastructure the people want them demolished. The structures don't adapt to the closely linked work-live social system of Dharavi. New buildings fall in disrepair because there is no collective maintenance strategy. New walled compounds do not relate to the rest, deepening segregation in ghettos with dark social forecasts.

Main failures are:

- Displacement of dwellers with resulting destruction of pre-existing social networks.
- Difficulties to plan for city-wide infrastructure continue and extensive areas of slums result in bad quality projects and poor infrastructure.
- Disruption of productive activities and the city is fractured into enclosures without fluid integration to rest of metropolitan areas.
- Finally, displacement to transition camps tends to replicate the problem.

"partnerships should not be seen merely as means of extending market forces, but rather a means of reaping social and environmental benefits from them". [1]

[1] Payne, Geoffery, Making Common Ground. Public-private partnerships in land for housing. Intermediate Technology Publication, UK, 1999

There are three main groups of actors, **knowing their need and desires is the base of a successful reinvention:**



What do they want?

- The right “to stay put”.
 - To keep the way of living.
 - Preserving the community ties and organization.
 - To keep the home/work relationship and the productivity.
 - To receive new housing units in exchange for their homes.
 - Better amenities and services, particularly better education and sanitation.
 - To reduce transition camps to minimum.
- A healthy and clean Dharavi.
 - To preserve the productive capacity of Dharavi, and its self sustainability.
 - A better connected and integrated Mumbai.
 - A Mumbai competitive in a global world.
 - To raise investments from the private sector.
 - An example of how to deal with the slums of Mumbai and India.
- The right to build in the center of Mumbai.
 - Investment opportunities with high rent.
 - A Mumbai competitive in a global world.
 - Well predisposed dwellers, willing to participate.

In Dharavi's long process in search of improvement, many proposals have been imagined and taken into practice. Concentrating, razing or exchanging properties; letting it be, and superficial improvements of appearance also. They have satisfied some of the actors but never all of them.

We believe **we can bring all actors into a fair deal**, and through the process have huge gains for India.



To progressively substitute huts by buildings



To demolish everything



To keep everything

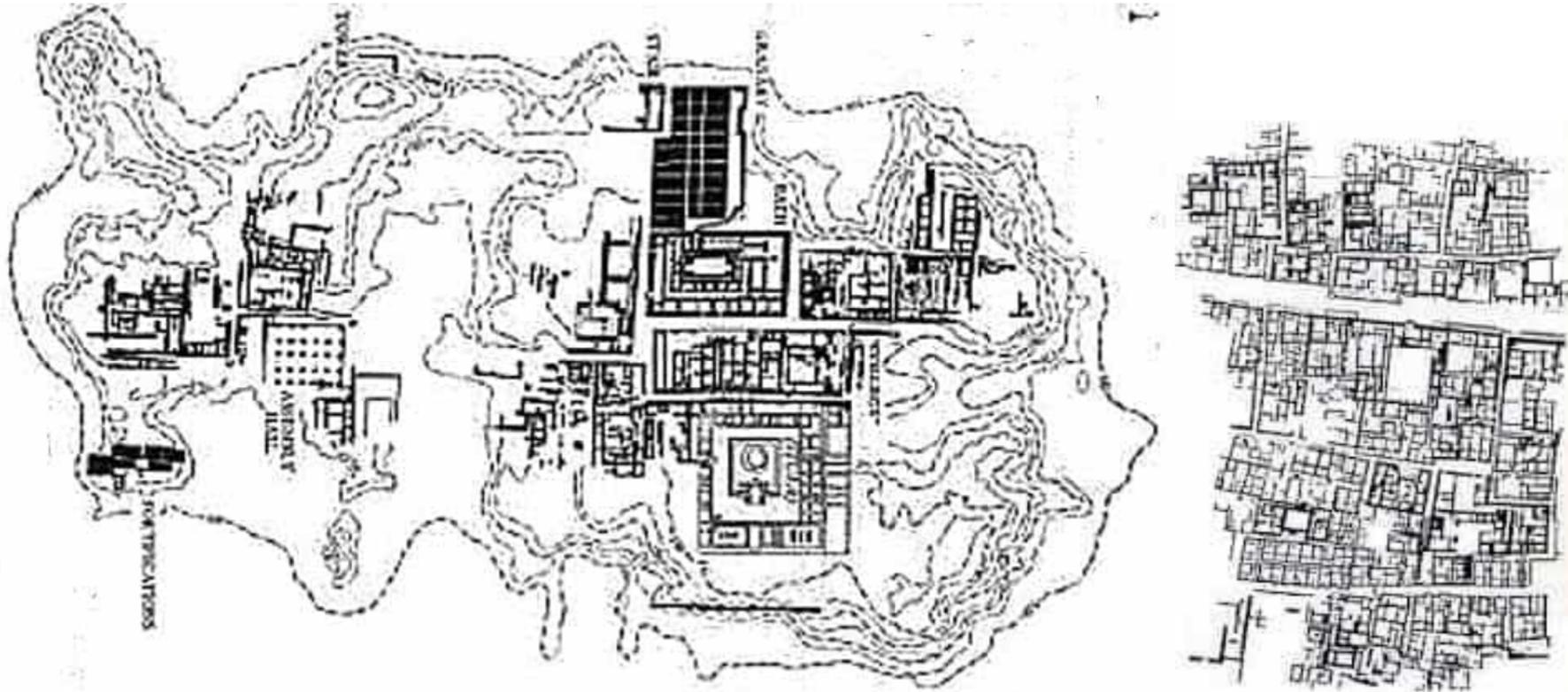


To triple the density to make space for real estate investors



Looking for solutions to please all the actors , and since the Colonial Portuguese and British actions did not had lasting influence in the Indians urban setting, **the trace leads to the ancient city**

A.E.J. Morris ⁽¹⁾ resumes the formation of Indian cities is framed in one of seven civilizations. Harappa is one of the dead cultures which helped develop western civilization. Some of their main settlements are Harappa, Mohenjo-Daro y Lothal. These first cities were very densely populated, had nonagricultural activities and were divides in two fundamental parts. The **“elevated city”** over adobe bricks and surrounded by walls as protection from floods, where administrative and religious centers were located. The **“low city”** grouped artisans sectors residential areas, storage facilities disposed in orthogonal grid. ⁽²⁾.



This form of city disposition, provided with stores up to three stories high along narrow corridors connected to wider streets in straight angles, is a feature which appears on informal settlements of India, particularly in some sectors of Dharavi.



(1) A.E.J. Morris (1984), Historia de la forma urbana: Desde sus orígenes hasta la Revolución Industrial.

(2) See H. Dani (1992): Critical assessment of recent evidence on Mohenjo-Daro.

Our proposal is based on the creation of new ground:

Dharavies need to be near the street. Stacking their houses up does not fit their needs. The ground floor is so densely occupied that construction becomes impossible. City managers can't satisfy the needs of amenities for lack of space, so we need to create **new ground**.

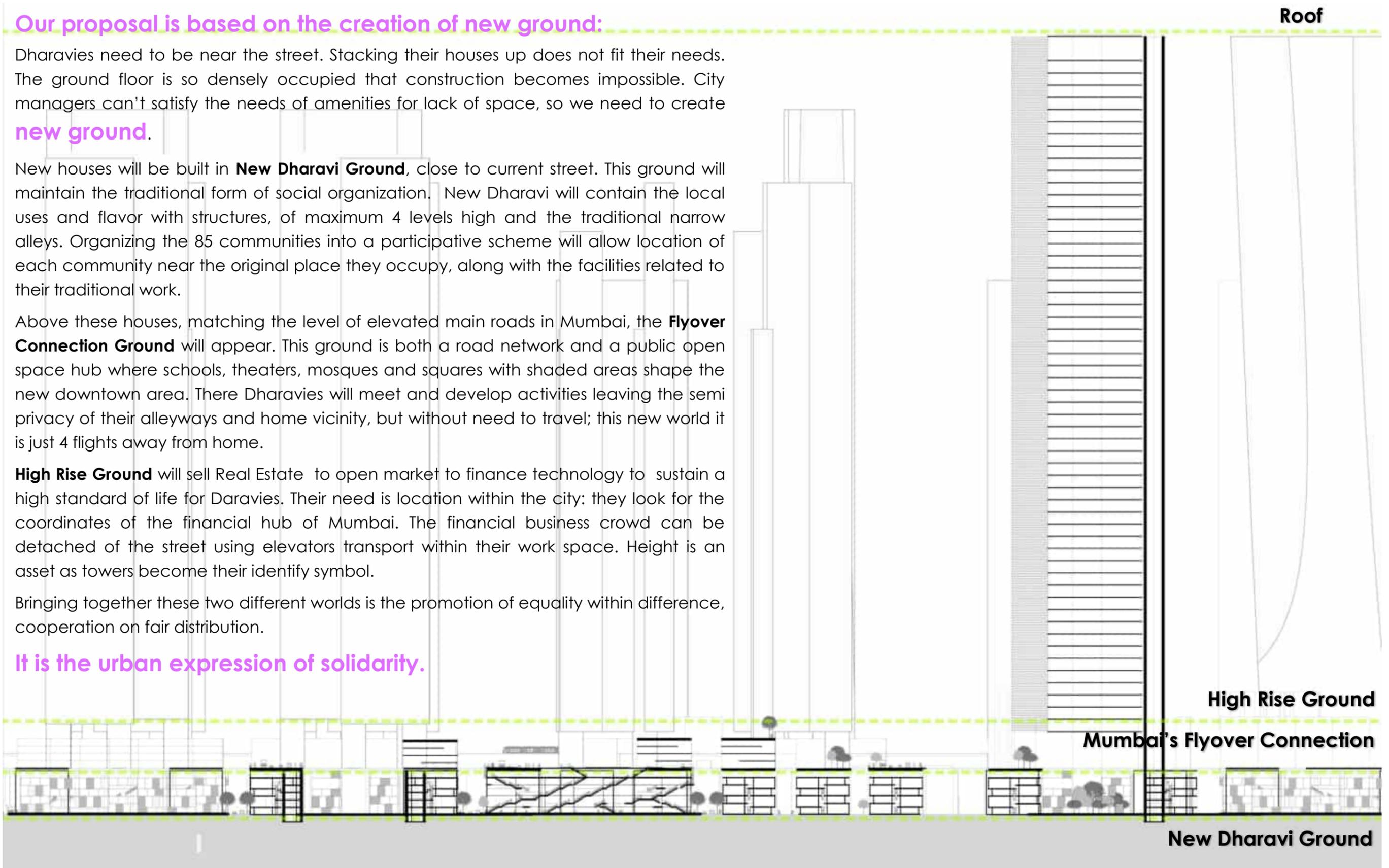
New houses will be built in **New Dharavi Ground**, close to current street. This ground will maintain the traditional form of social organization. New Dharavi will contain the local uses and flavor with structures, of maximum 4 levels high and the traditional narrow alleys. Organizing the 85 communities into a participative scheme will allow location of each community near the original place they occupy, along with the facilities related to their traditional work.

Above these houses, matching the level of elevated main roads in Mumbai, the **Flyover Connection Ground** will appear. This ground is both a road network and a public open space hub where schools, theaters, mosques and squares with shaded areas shape the new downtown area. There Dharavies will meet and develop activities leaving the semi privacy of their alleyways and home vicinity, but without need to travel; this new world it is just 4 flights away from home.

High Rise Ground will sell Real Estate to open market to finance technology to sustain a high standard of life for Daravies. Their need is location within the city: they look for the coordinates of the financial hub of Mumbai. The financial business crowd can be detached of the street using elevators transport within their work space. Height is an asset as towers become their identify symbol.

Bringing together these two different worlds is the promotion of equality within difference, cooperation on fair distribution.

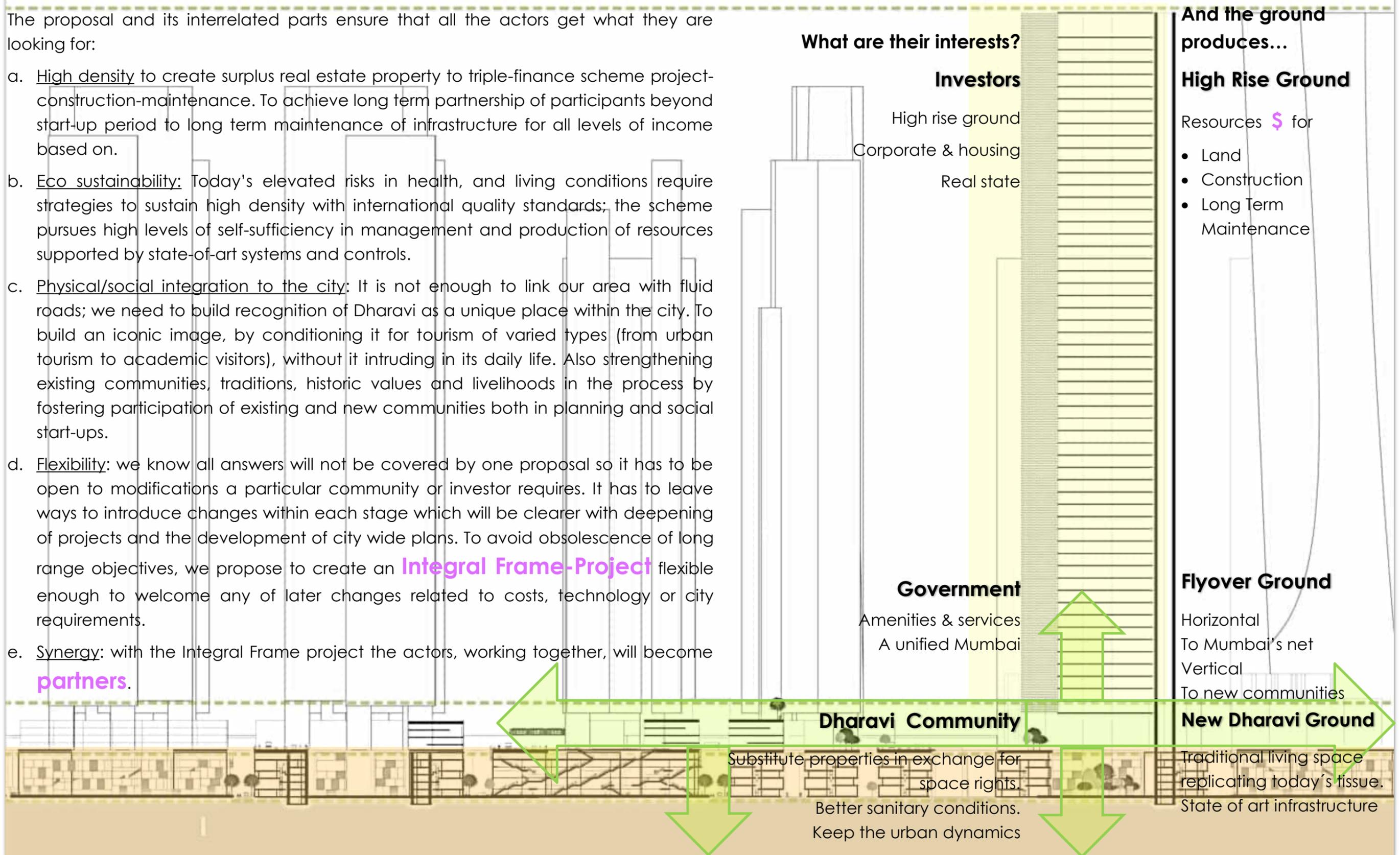
It is the urban expression of solidarity.



Why Smart Dharavi?

The proposal and its interrelated parts ensure that all the actors get what they are looking for:

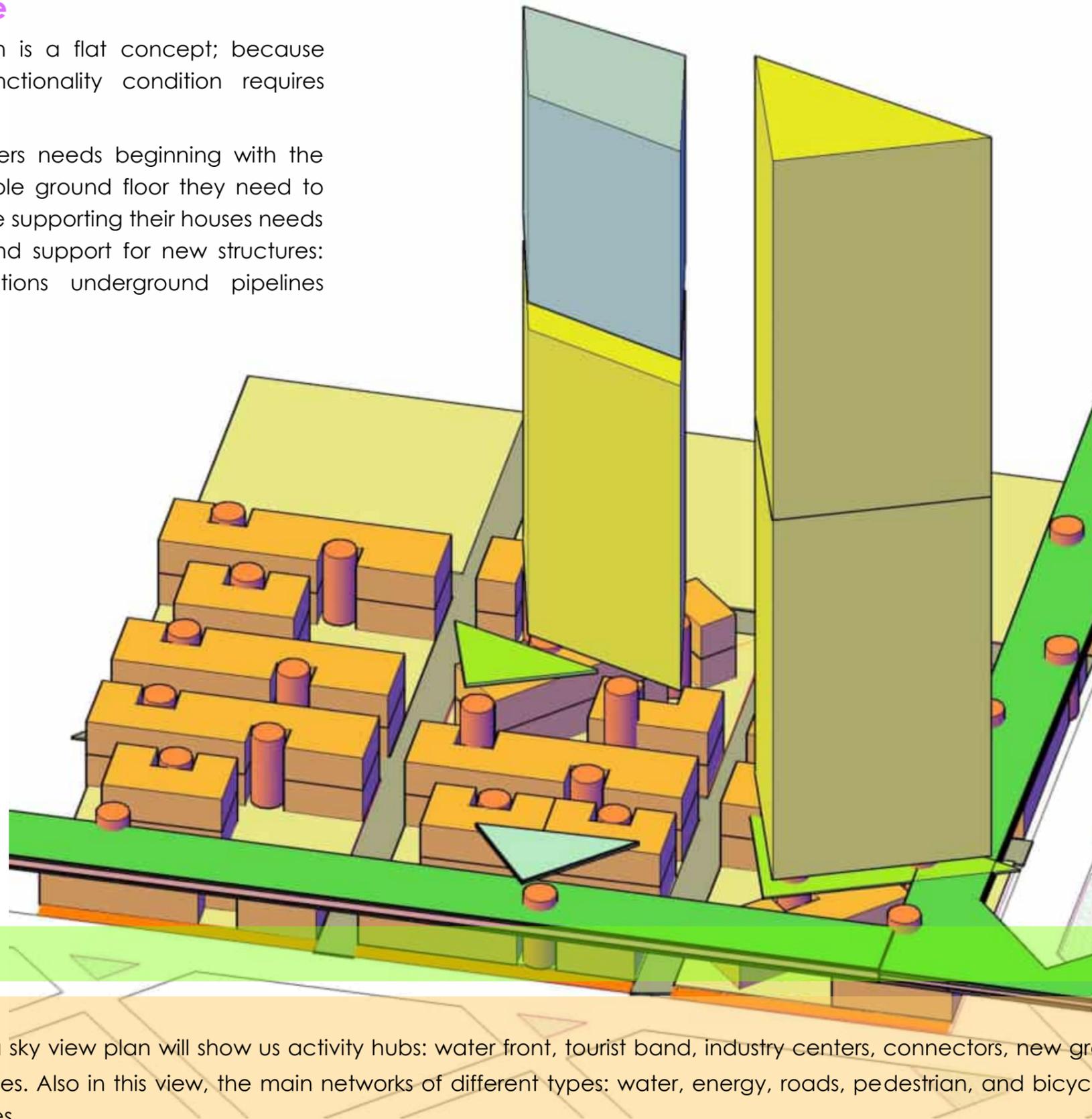
- High density** to create surplus real estate property to triple-finance scheme project-construction-maintenance. To achieve long term partnership of participants beyond start-up period to long term maintenance of infrastructure for all levels of income based on.
- Eco sustainability:** Today's elevated risks in health, and living conditions require strategies to sustain high density with international quality standards; the scheme pursues high levels of self-sufficiency in management and production of resources supported by state-of-art systems and controls.
- Physical/social integration to the city:** It is not enough to link our area with fluid roads; we need to build recognition of Dharavi as a unique place within the city. To build an iconic image, by conditioning it for tourism of varied types (from urban tourism to academic visitors), without it intruding in its daily life. Also strengthening existing communities, traditions, historic values and livelihoods in the process by fostering participation of existing and new communities both in planning and social start-ups.
- Flexibility:** we know all answers will not be covered by one proposal so it has to be open to modifications a particular community or investor requires. It has to leave ways to introduce changes within each stage which will be clearer with deepening of projects and the development of city wide plans. To avoid obsolescence of long range objectives, we propose to create an **Integral Frame-Project** flexible enough to welcome any of later changes related to costs, technology or city requirements.
- Synergy:** with the Integral Frame project the actors, working together, will become **partners**.



A 3D concept urban structure

We cannot speak of land use, which is a flat concept; because Dharavi's total occupation and functionality condition requires optimization of spatial use.

Optimizing means satisfying the partners needs beginning with the dwellers occupying 90% of the available ground floor they need to stay on their coordinates but the surface supporting their houses needs leveling work for it to function as sound support for new structures: drainage sloping, channels connections underground pipelines tunnels, basements etc.



Vertical organics If regarding sections we find hubs on base Dh. the assets maintained on the newly created. New amenity areas, enough to quench the present deficit of religious. New commercial, outdoor areas, educational and cultural, according to future population, will be located on flyover ground 4 levels up from ground floor. The vertical transport system composed by elevators shafts for pedestrian use, stairs to upper homes. vehicle ramps for access to parking or flyover around and elevators to

Horizontal organics watching a sky view plan will show us activity hubs: water front, tourist band, industry centers, connectors, new green areas and Ma St. Park, historic sites and traditional communities. Also in this view, the main networks of different types: water, energy, roads, pedestrian, and bicycle, trains and monorail give functional structure of connection issues.

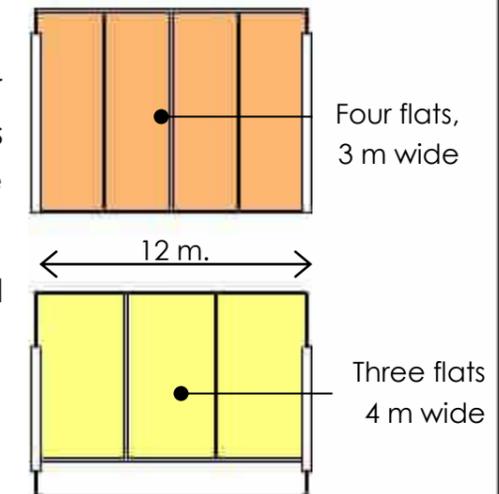
To allow the most efficient use of each ground, the adequate interaction between them and for having the sun and air penetrating in the lower levels, it is fundamental to have **an organism with all parts fitting together.**

The system is based in a 12 x 12 meters grid, which is adequate for the flats, for the open spaces and also for the streets.

The flat units

The module originates in the two types of flats proposed: four three meters width, or three of four meters width. They have a similar area (27.5 m²), but each one enjoys different features: the narrow one has high ceiling, so the users could built a loft. The wide one has a balcony, so it shall be useful for people that need exterior space.

The modular units system simplify the building process, and also provides clean and open spaces that can be customized for each family.



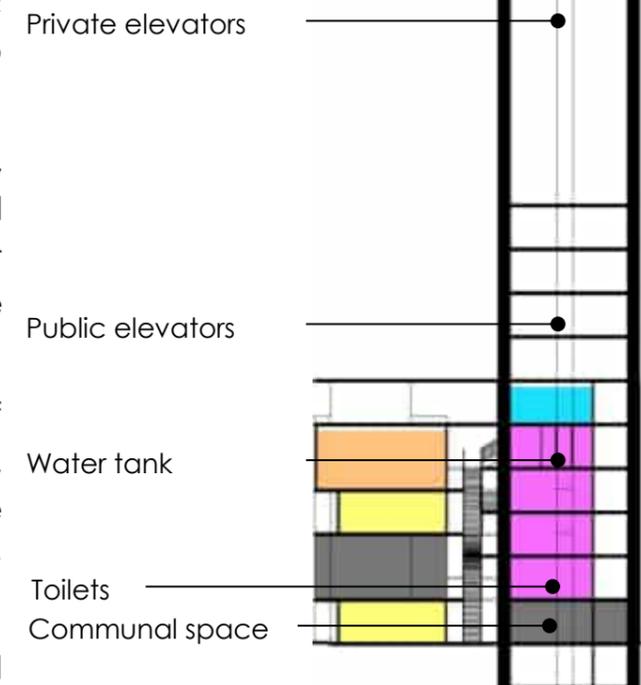
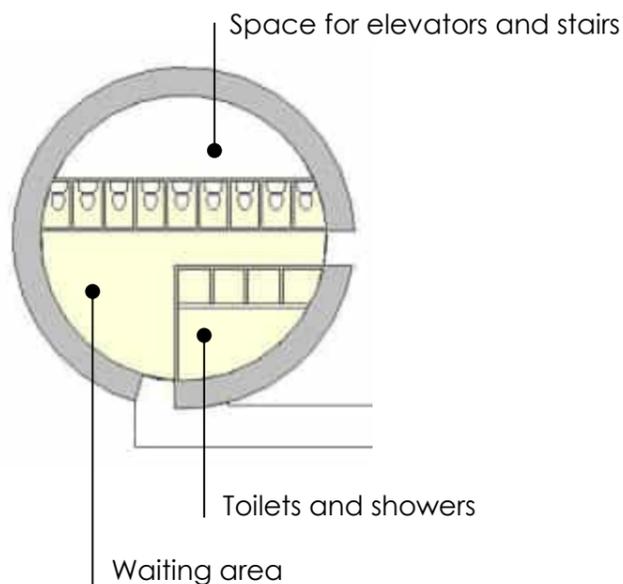
The shafts

“In India, a public toilet is not simply a toilet. Public toilets are community centers where people meet to exchange news about what is happening in the community, or in the family, or what happened the other day or last night. When you go to a public toilet, you get all the news about the settlement. In fact, today in India, if you want to mobilize people, you first go to the public toilets.” (1)

In accordance with this idea, the proposal includes a system of semi-private toilets, accessible by the building’s aisles. The toilets are piled up inside the pieces we call shafts. There is approximately one toilet each 15 people, improving significantly not only the existing condition but also the offer of the current toilet programs, and there are enough to separate services for men and women.

The shafts interconnect all the grounds, serving them all. They are the main structure of the towers. From the Flyover Connection Ground down the shaft contains the toilets, the water tanks and communal spaces, till the High Rise Ground they accommodate public elevators and stairs, and from there up, the private vertical circulation of the towers.

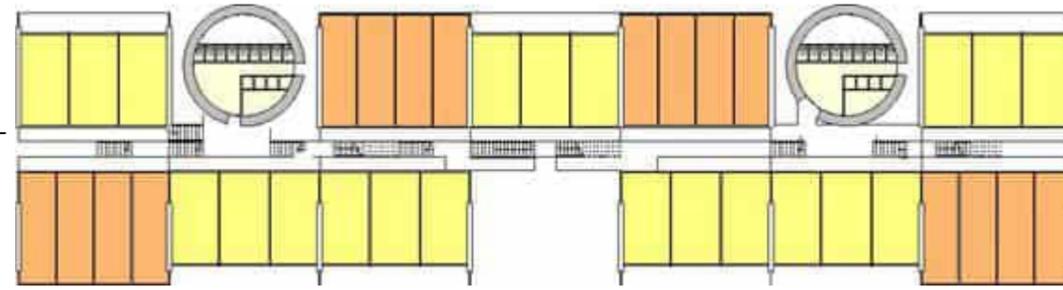
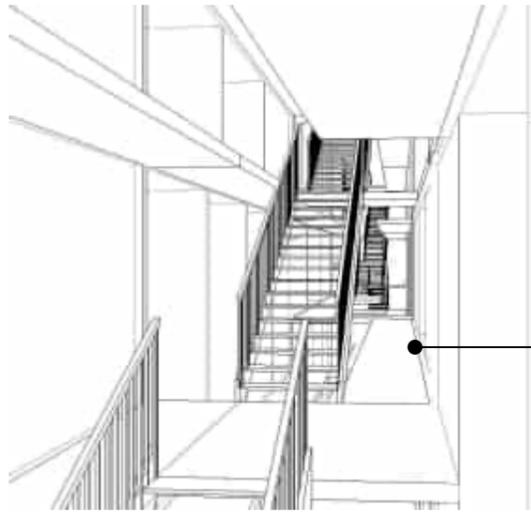
To the stage of competition, all the shafts are equal and round, their specific form will depend on the design of the towers.



(1) JOCKIN ARPUTHAM , president of the National Slum Dwellers Federation of India and leader of Slum Dwellers International, interviewed by RASNA WARAH World Urban Forum I, Nairobi, Kenya, 29 April 2002

The housing unit

The flats and shaft are combined to make the housing units. More than individual multifamily buildings, the housing units are integrated with the streets, their interior spaces flowing continuously from the lanes, courtyards and squares, in a similar way it happens now in Dharavi. The low-rise structure allows all people to live and work near the street and eliminate the need for difficult to maintain elevators.



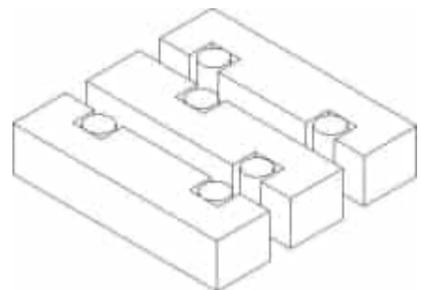
The interior alleyway, with its open aisles and stairs allows the wind inside the building, ensuring cross ventilation for all the dwellings.

Combining the two kinds of flats generate fluid interior spaces and also an exterior image showing the individuality of each unit.

In addition to the dwellings, the housing units have communal open spaces, where is possible to relocate productive activities, where the small children can play and women can share the house chores. Depending on its length, there are long and short residential units.

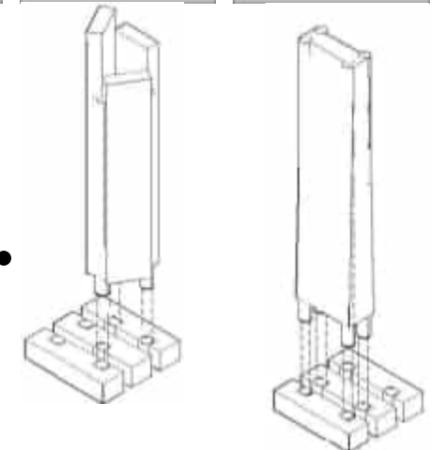
The blocks

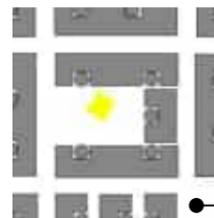
The blocks are the main component of New Dharavi, and host all the other components. Each block measures 84 x 84 meters (12 x 7), with streets 12 meters wide. They occupy the **New Dharavi Ground, from 0+00.00 to 0+15.00**.



The basic block is the **“Street Block”**, containing three buildings in a row. The buildings define two alleys, generating the basic public space in New Dharavi: the narrow pedestrian lane and its activity.

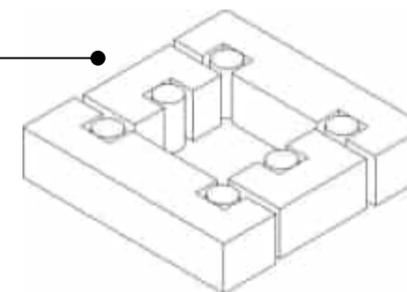
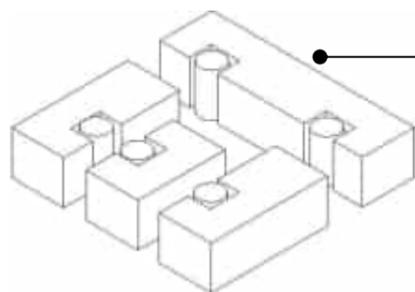
Changing the location of the shafts in the housing units, the block permits a variety of towers above it, as well as many different public spaces over it.



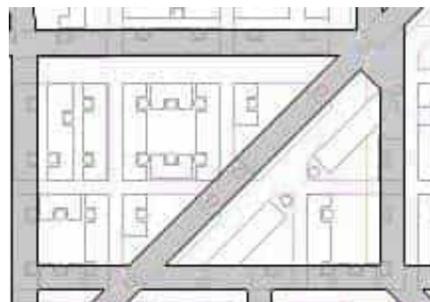
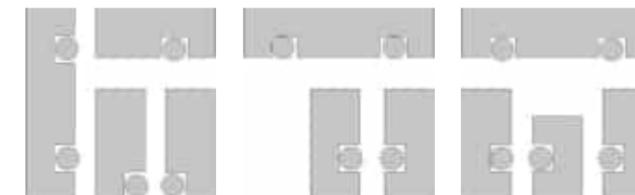


The “**Courtyard Block**” hosts a courtyard in its center. This 20 x 20 m space, could be public or private, and be used for communal or industrial activities, so the communities that need to work together can be relocated. Maintaining their traditional way of doing things but providing adequate services should trigger in a much more productive industry.

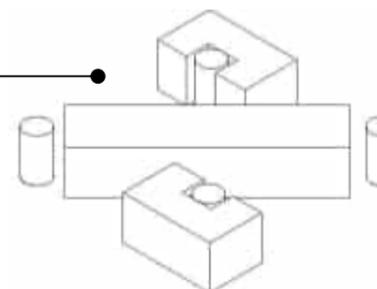
The block can be closed or open; integrating bigger urban spaces and making space for existing structures.



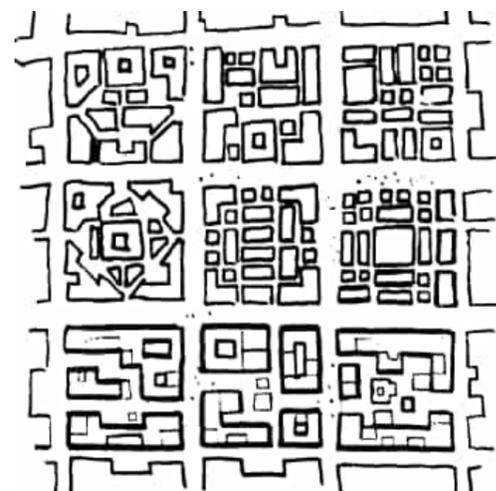
In the “**Square Block**”, a street widening generates small squares either in the corner or in the middle of the block. The urban tissue of New Dharavi is enriched by its several variations that also allow for different Fly over configurations.



As the Mumbai’s Flyover connection requires streets in multiple directions, the “**Diagonal Block**” is needed.



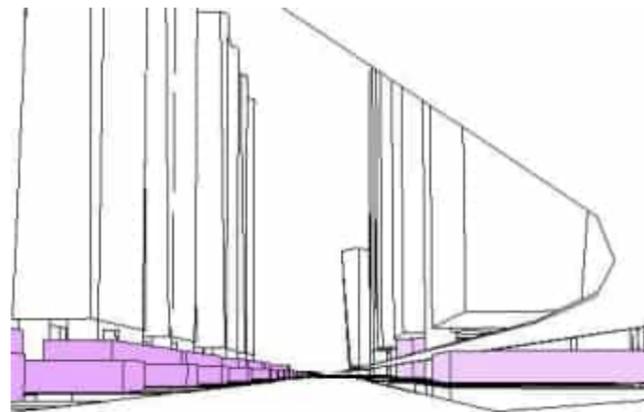
Each one of the block types have different construction areas, and a different number of flats. Some are, therefore, more efficient for the New Dharavi Ground, others are good tower hosters. The number of individual flats fits roughly with the quantity of families in a cluster, and the variants will be useful in negotiating with the communities.



The blocks working together⁽¹⁾

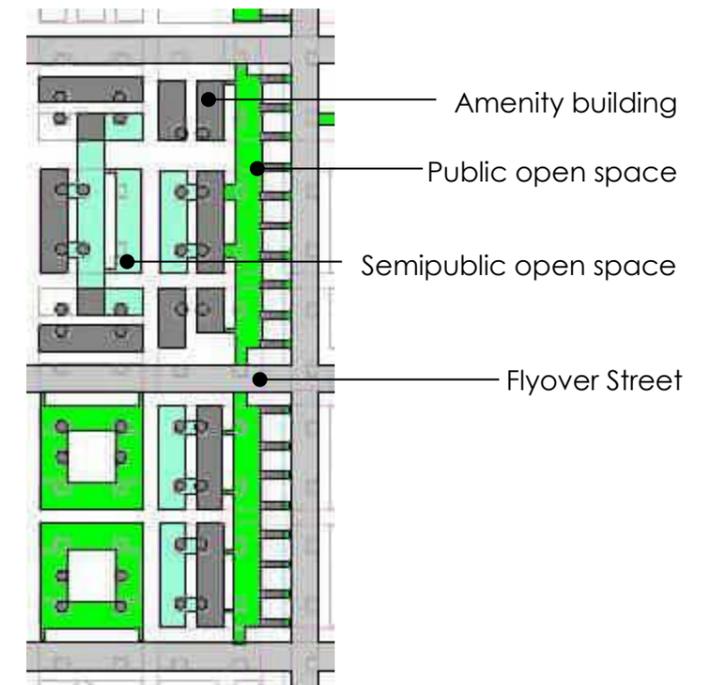
	Residential Units	Number of flats	Construction area (m ²)	% flat area	Open common area (m ²)
Street Block	3 long	468	24,862.86	50.82%	2,016.00
Courtyard Block	2 longs +2 short	444	24,862.86	48.22%	1,485.98
Square Block	1 long+ 3 short	442	20,825.24	57.31%	2,300.74
Diagonal Block	1 long+ 2 short	312	16,575.24	49.57%	3,161.88

(1) Sketch of Vidyadhar Nadar from Balkrisna Doshi: Architecture for India. William J. Curtis ,ed. © 1988 Rizzoli International Publications, New York.



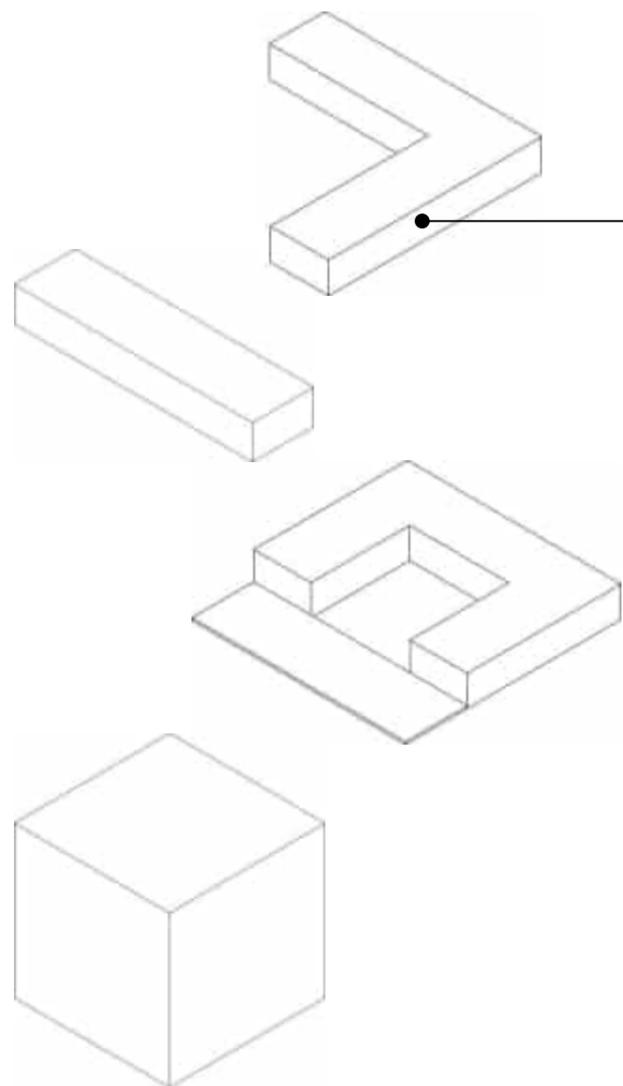
Between **0+15.00 and 0+30 the Flyover connection Ground** develops. It contains the streets connecting with Mumbai, the public transport and the amenities and services.

Its central location in the middle of New Dharavi and the High Rise grounds is ideal to keep one of the fundamental values of the Indian's cities: "The idea that an entire neighborhood must be homogenous in terms of class goes against the way in which urban India operates. Middle-class and upper middle-class homes often prefer to have service-oriented people living around them or in their vicinity. ... Due to the loss of a mixed income crowd in central neighborhoods, India may lose one of its most democratic urban dimensions" (1).



The Amenities

The buildings and streets at this ground have only two restrictions: to fit above the housing units must have a fixed width: 22 m., and for maximizing the available open space their entire roof must be habitable.

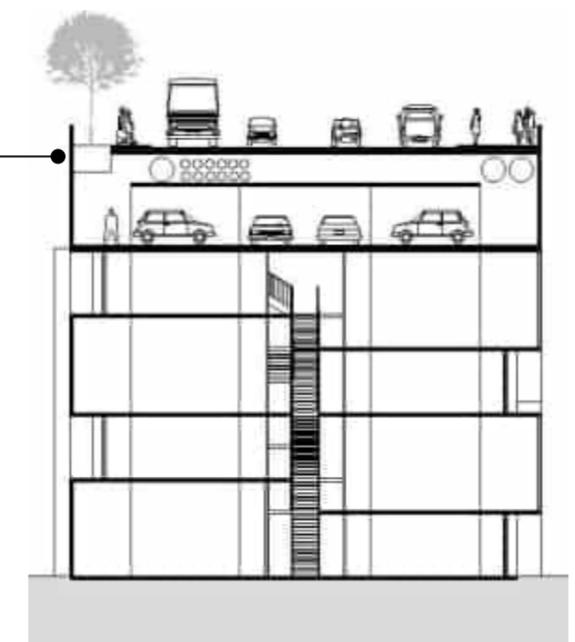


This leaves a broad margin for designing many different buildings for the health, education, and recreation, to be shared for all the inhabitants. To preserve the light and sun in the New Dharavi Ground, the amenities buildings will be above the blocks, and will be connected among them y with the streets with bridges that can or not be habitable.

The parking

The level immediately below the streets in the Flyover Ground will be a parking facility with capacity for 26.000 cars. The provision of occupancy information panels will ensure the most efficient use of the space, sharing the spaces among the commercial and residential uses. Thought the elevators inside the shaft, and the stairs system the parking network can connect to private or dedicated areas, below and above the Flyover Ground.

A system of ramp modules will allows picking the route either on New Dharavi roads or by Flyover Connection if leaving Dharavi.



(1) The economic Times Magazine-Special Report, August 31, Sep 06, 2014. Dharavi's Digital Leap

The Public spaces and streets

The elevated streets & public space in the Flyover Ground is a multiple link to Mumbai allowing improvement of vehicular network without disrupting existing urban tissue. Will also host Connecting enters for different Transport Modes: buses, monorail and train means.

The network connects with Western and Eastern Express Highway.

Commercial activity, squares, amenities, green areas, will be attached to secondary roads implementing a new high ground supplying the amenities needed to reach acceptable standards. The flexibility of this grid allows building amenities as they are required with easy connections to New Dharavi and High Rise Grounds.



Industry and transport

In addition to the small industrial activities happening in the housing units, there will be an offer of new Industrial areas developed to technical standards, situated near the train stations. This proposal goes in line of what have been asked for the people: "We have suggested that the government create industrial zones within Dharavi...one for potters, one for garment manufacturers etc...like the way they have done in MIDC [Maharashtra Industrial Development Corporation]" (1)



Despite its dynamic industrial and economic activity, the work conditions in the informal sector of Dharavi are at the moment deplorable. The new Dharavi smart city aims to develop an organized, non-toxic, productive and sustainable industrial pole.

(1) The economic Times Magazine-Special Report, August 31, Sep 06, 2014. Dharavi's Digital Leap

With near 7.30 Ha. the new industrial buildings will provide adequate areas with high safety normative for medium range industrial entrepreneurship, complemented with multiple use exhibition space to promote international commerce.

Both Mahin Sion Train Stations will have a new bus station on Flyover Ground, becoming multimodal transports hubs. The stations will have levels for train and bus passengers, for vehicle maintenance and parking with drivers services.

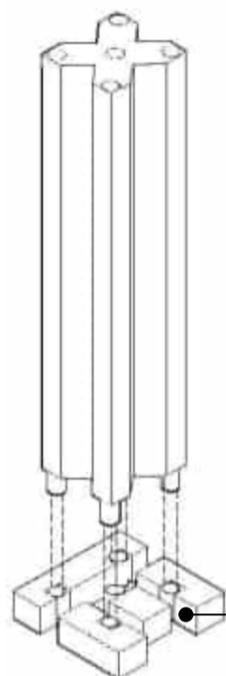
The transport facilities will be combined with a complete Commercial Mall and Light Industrial area, to facilitate the exchange of goods and the financial sustainability of the transport system. Over the industrial space will be space for the Bus Depot, freeing land for the first building stage. The depot can accommodate 230 bus units with facilities on two levels, maybe one for public connections and other for maintenance and repairs.

They will be covered by elevated parks apt for collective gatherings, fairs, weekend markets and festivals to introduce the cultural elements not present so far. A construction presenting two faces inside industrial activities, outside recreation and cultural.

The towers

The towers populate the **High Rise Ground, from 0+35.00 to the sky.** The towers will be built to modern, even futuristic standards. Like the other pieces, should follow some rules to fit in the system: (1) as they are hosted by the blocks, their structure has to correspond with the location of the shafts, as its vertical circulation; (2), should be empty till 0+35.00, to make space for the lower grounds.

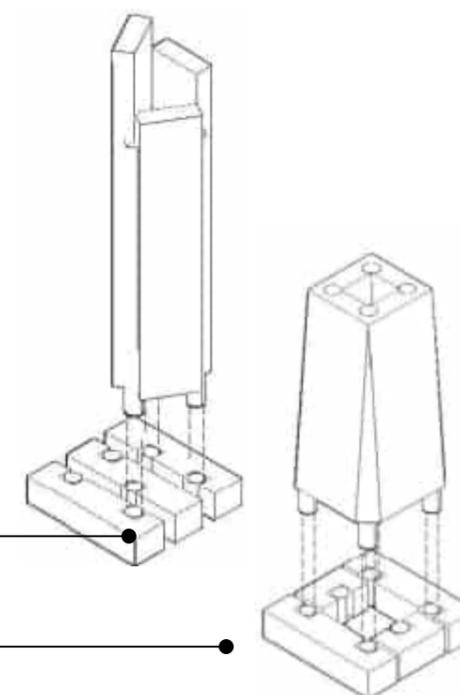
The towers are the rental component, and each developer should have freedom to build according with the specific use: residential, corporate commercial or hotel, and with its own image. Everybody should be encouraged, however, to use the most efficient and sustainable systems available.

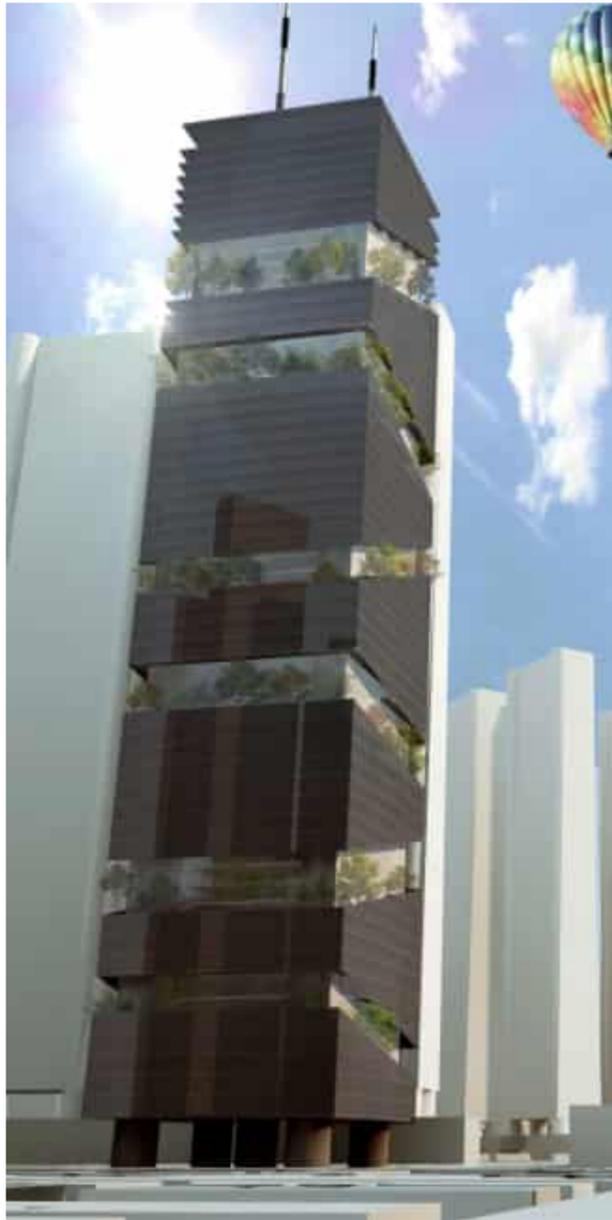


Depending on the location of the structure, there are several basic tower types:

The "**Central Tower**" has a structural core and four structural corners, as have most of the highest towers in the world. It is hosted in a special Square Block.

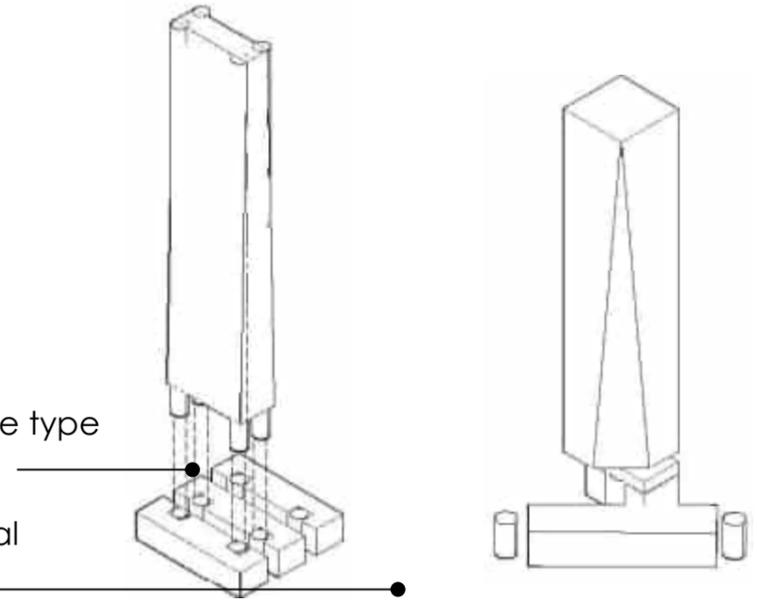
Both the "**Triangular Tower**" and the "**Void Tower**" have an empty core, so they could use natural light and ventilation, and therefore are appropriate for residential use. The first is hosted by the Street Block; the second can be built above the Courtyard Block.





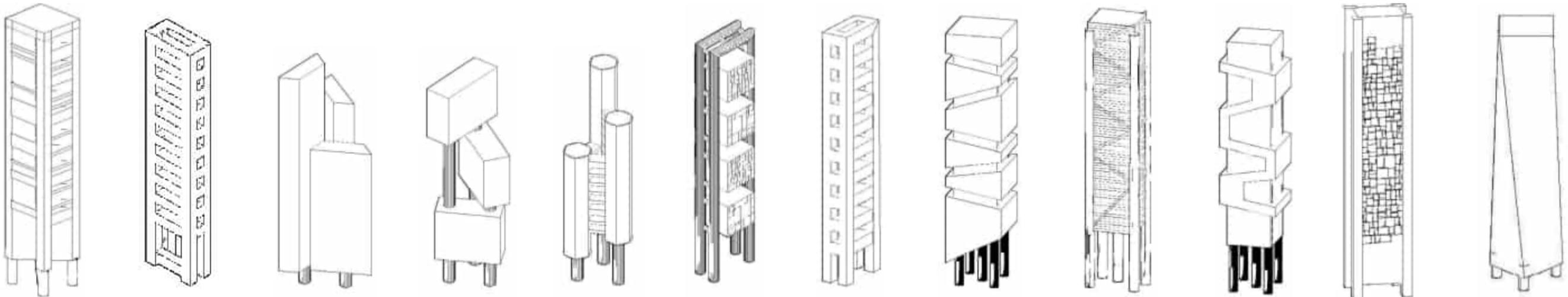
The “**Long Tower**” is supported in four pillars, one in each corner. Match with one type of Street Block, and can also be located as a bridge between two blocks.

Finally, the Diagonal Square nests the “**Continuous Tower**”, without any structural restriction, as it could go solid to the ground.



The basic types can be used for building and infinite set of variations, not only in image but also in height and construction area. These last number, however, it is fundamental to check the financial feasibility, so here there is an example of possible conditions:

	Shaft x Tower	Floor area (m ²)	Number of floors	Total Area (m ²)	% Rental	Rental Area (m ²)
Triangular	3	1,370.53	55	75,378.88	80.00%	60,303.10
Void	4	1,827.44	40	73,097.60		58,478.08
Central 1	5	3,406.28	75	255,470.84		204,376.67
Central 2	5	2,485.79	75	186,433.99		149,147.19
Central 3	5	3,027.36	75	227,052.18		181,641.74
Long	4	1,573.80	60	94,427.86		75,542.28



The proposal aims to preserve the way of life and urban values of Dharavi and, although a reinvention involves the replacement of many existing structures for other structures with adequate services, it is essential, from a socio-cultural point of view, the preservation of many buildings, public spaces or facilities. It is fundamental, therefore, to have clear guidelines for the harsh decision process:

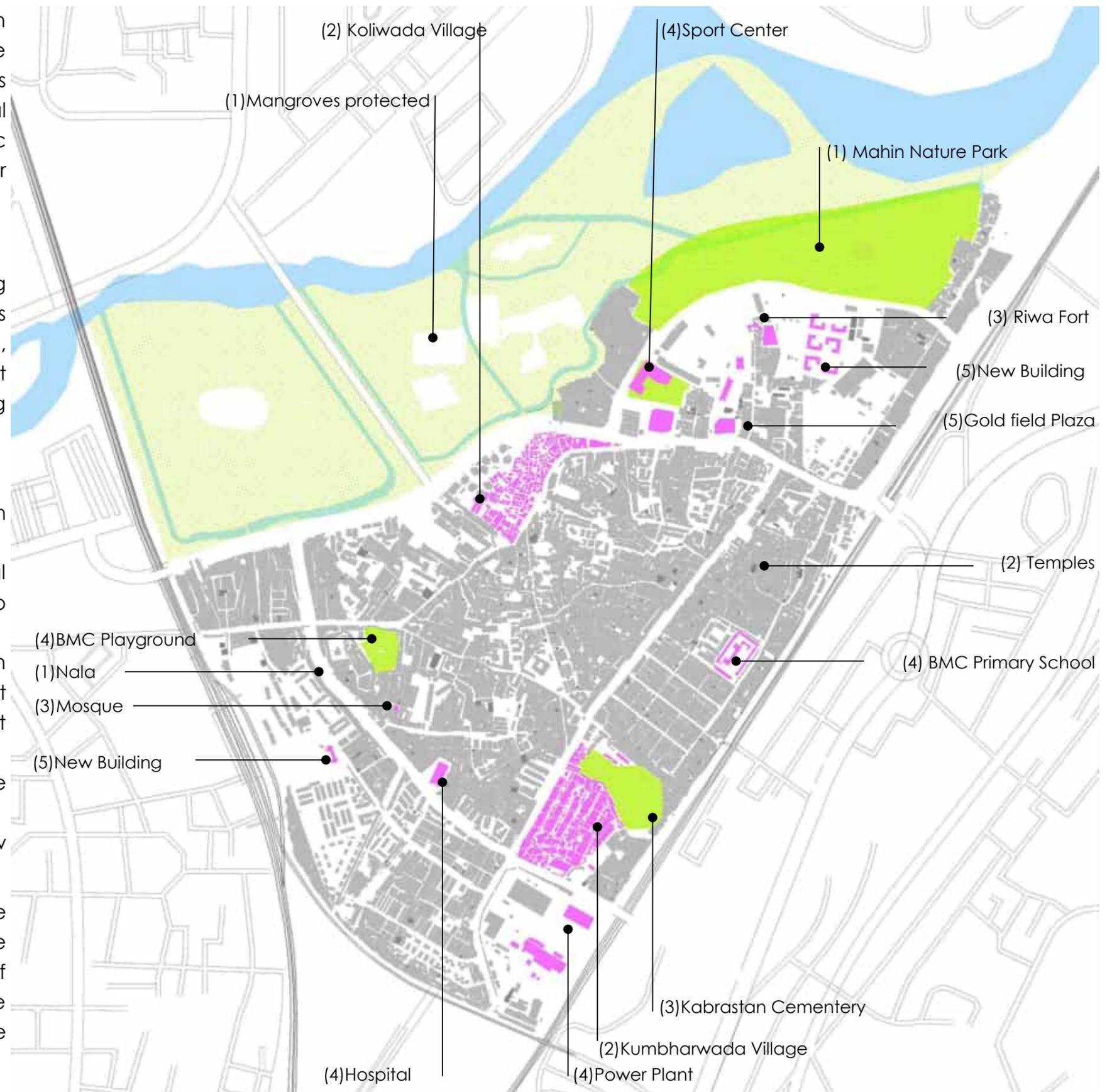
What should be preserved?

At this stage there is not enough information for deciding what is worth to keep. Every little box in the map represents years of a family work, every open space is intensely used, and it should be studied in detail. In that sense, the map at the left should be understood as a suggestion, showing criteria but not necessarily specific structures.

Here the things representing what are to be keep:

- (1) For environmental reasons, the mangroves, the Mahin Park and the nala should be kept.
- (2) The Koliwada and Kumbharwada Villages have legal land tenure, so although they should be integrated to the whole project, have a special status.
- (3) There are a number of buildings and spaces with historic, architectural or symbolic value, as the Riwa Fort or the Mosque. It could also be needed to protect other temples.
- (4) Some main amenities are well maintained or expensive of substituting, and could be preserved.
- (5) Some private buildings are big, well-constructed of new enough.

Most of the residential buildings do not seem to have sufficient value to be kept, and some have been asked to be demolished: "...it will be a proper building. Not like this one. If it takes ten years, it will be better than the conditions we're living in today. If MHADA doesn't destroy this building, the mahila mandal will tell them to, and they will listen" ⁽¹⁾



(1) Weinstein, Liza (2014-04-01). The Durable Slum: Dharavi and the Right to Stay Put in Globalizing Mumbai (Kindle Locations 3377-3380) University of Minnesota Press. Kindle Edition

The **New Dharavi Ground**, designed to accommodate residents and develop their social and work activities, is ordered based on a lattice frame adequate to main current urban situations. The new structure is based on a system of square blocks, reinterpretation of the cluster, improving construction conditions, health, sunlight and services.

From this block “cluster” originates not only urban grouping but also road and building structure belonging to higher grounds. The use of the grid, which rememorizes the historic city in India to identify with the former **lower city**, produces a hierarchical street system progressing from public to private from Main Street, Local Street, Pedestrian Lane and Ally Way.

The scheme is developed based on efficiency of spatial use, aligning with 90 Feet Road and extending Lal Bahadur Shastri Road. Significant roads like Mahin Sion Dharavi Link Road and Depot Road and connections by the Sion-Bandra Link Road and the reinterpretation of the tracks 60 Feet Road and Station Road are respected. Also joining the new urbanism and the Villages of Koliwada and Kumbharwada and the Kabrastan Cemetery and major religious, electrical, hospital, educational, sporting and commercial facilities.

Similarly, the location of the new urban grid deployment adapts in the field to accommodate the path of the extended Nalas proposal and provide an edge to enjoy the scenic presence of Mahin Natural Park and extensive mangrove area.

The plot gets adjusted to pre-existing issues and maintains the spirit and relationships of the original organization. But above all, the proposal takes full advantage of the territory to include the cluster blocks necessary to generate a sufficient supply of housing for all current residents with substantial improvements in their quality of life.



The Mumbai's Flyover Connection Ground ,

the **high city**, emerges as intermediate ground by vertical cluster management, generating by the reticular pattern of New Dharavi Ground. This ground, through a network of traces arranged in a grid crisscrossed by large diagonals, provides a system of streets, public spaces and elevated transport lanes that perform the necessary connections between the territory of Dharavi and the rest of the city, incorporating this urban sector to the dynamics of large Mumbai.

Supported on the structures of the lower ground, the Housing Units and Shaft structures, is the second level road system. The Flyover Ground have to handle the high vehicular traffic connecting inner roads with Mumbai through Sion Flyover Western Express Highway. At the same time they offer scenic roads with great views of the city, as Mangrove, Mahin and Sion Flyover Sections. A monorail system runs across this ground from south to north, joining the Mumbai Metro network, which currently evades passing through Dharavi.

This intermediate ground is a meeting place and coexistence of the activities of different actors that make life in the city. But at same time it provides and solves the main services network location necessary to the modern city. It also supports main infrastructure utilities services, in a more accessible position to allow maintenance without disruption of the busy activities in New Dharavi. Pipes and cable work will be protected from flood events in horizontal ducts, rather than in more expensive underground channels. Service trucks will not obstruct traffic when accessing service areas.

This ground concentrates new business, hospitals, educational and cultural facilities along with plazas, parks and meeting spaces which complement the supply of urban dynamics for all the inhabitants of the great city of Smart Dharavi.

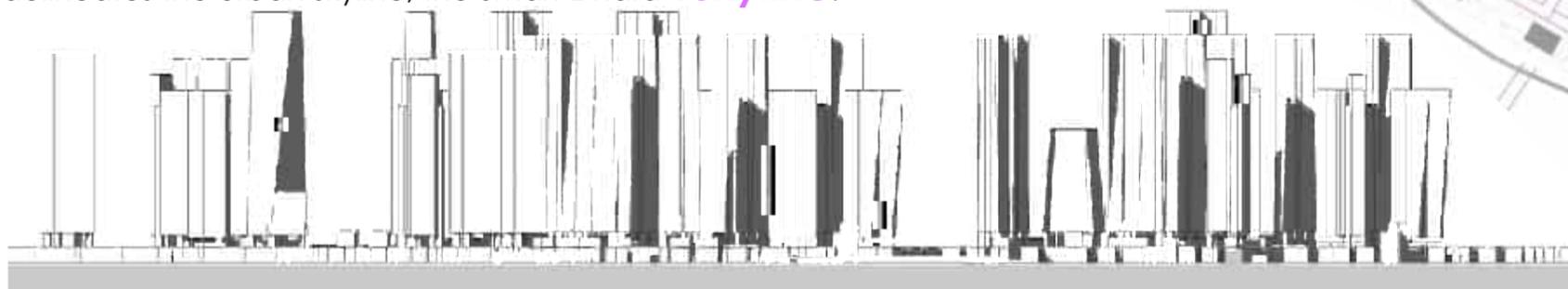


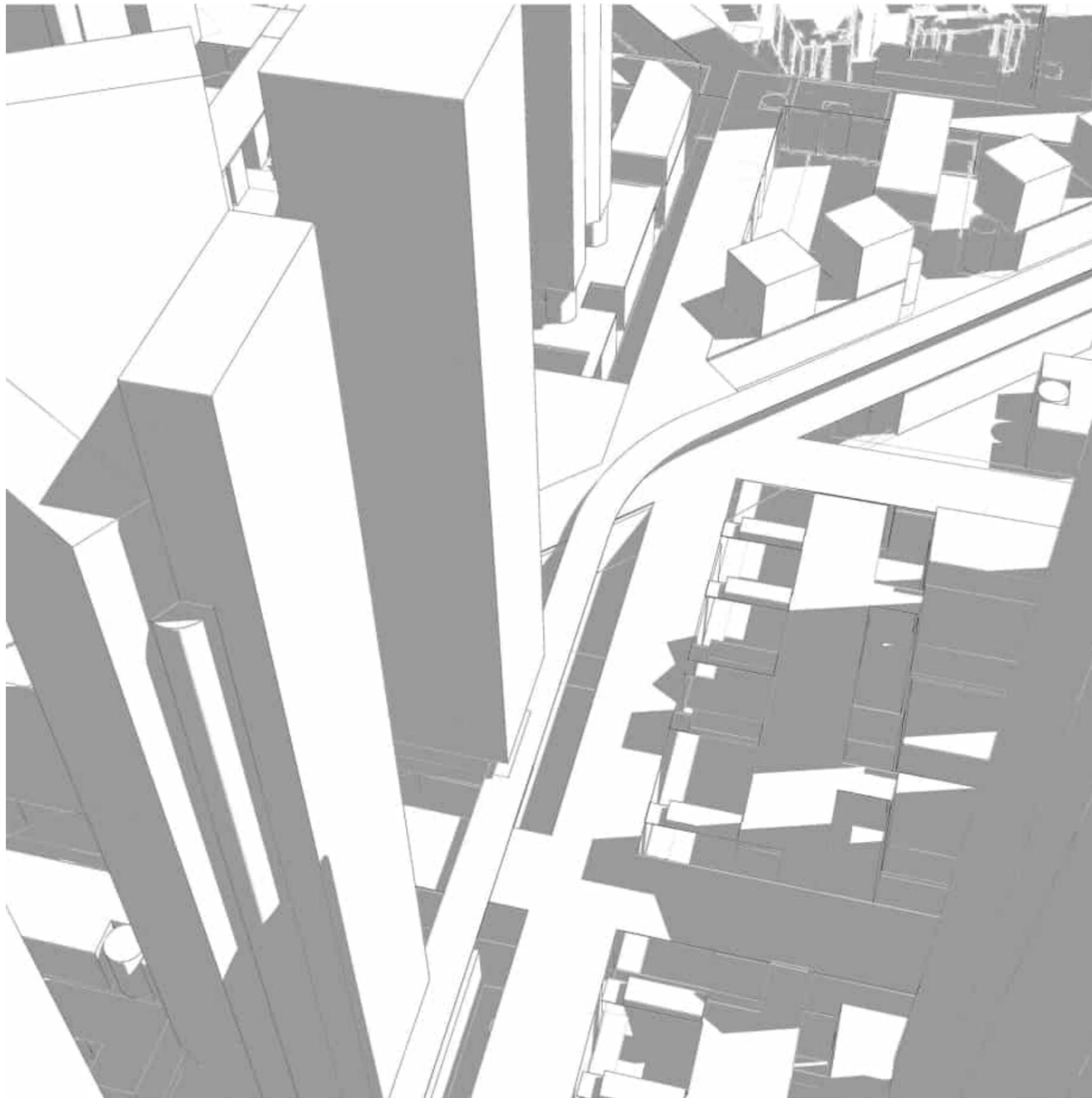
The High Rise Ground contains the taller buildings to be built in the new city Smart Dharavi, supported by the same structural base of Mumbai's Flyover Connection. Towers belonging to this vertical ground produce large elevated volumes that are physically supported in Shaft structures. Located flexibly over the cluster blocks without affecting illumination and ventilation of the lower grounds.

The towers will use the highest standards of technology both project and operation issues, to provide the new supply of office space for the large number of companies and corporations that want to locate in the new high Mumbai, and upscale residences challenging gravity to offer its residents impact city views. The structural and spatial design of the towers, supported only by hollow structures, allows future designers to manage degrees of freedom in design, in order to characterize each of them and give them identity.

The High Rise Ground represents the globalized level of Smart Dharavi, and therefore the great Mumbai; integrating landscape and tradition, experience and technology in an area of town that offer places of residence, services, work, tourism and framed within the most advanced trends of global architecture.

Finally, it is noteworthy that while the Ground New Dharavi represents local and traditional life of Dharavi, Mumbai's Flyover Connection provides support in service and infrastructure and the horizontal and vertical integration of urban dynamics, the Ground High Rise provides portrait of the new city, a global image, vibrant, dynamic, traditional, contemporary and futuristic at once. The High Rise ground delineates the urban skyline, the Smart Dharavi **skyline**.





An organism with all parts fitting together

The Smart Dharavi scheme can deliver satisfaction to all 3 levels of requirements by the use of team synergy in a collective effort to satisfy everyone's goal as a turnkey project. The partnership approach will align all efforts to one goal.

- There will be a dense use of valuable land obeying modern urban trends that indicate advantages of having mixed uses and income levels in any city sector. The scheme allows density variation according to the special conditions or variables of development, dependent of infrastructure or market requirements. Government will partner with developers waiving the price of public land to lower costs but ensuring the dwellers rehousing units are built and delivered before developers sell their product to free market.
- First satisfying variety of lifestyles in the social setting of preference: the offer of housing will be as varied as the Indian society but every home will share top location of Mumbai, excellent utility services and pre-existing social communities will remain intact.
- Important government issues will be attained by cross-subsidy is being used to harvest social advantages from market forces, the land price will be covered by the profits of high end real estate to be sold at market price. Necessary infrastructure will be possible with government supplying the projects to be included early in development schedule and financing.
- Top quality amenities will be included in the overall cost of the scheme adequate to future population and commuters. But the best feature is they are structured on a new meeting ground for all citizens to enjoy recreation, leisure and culture without the threat of floods.

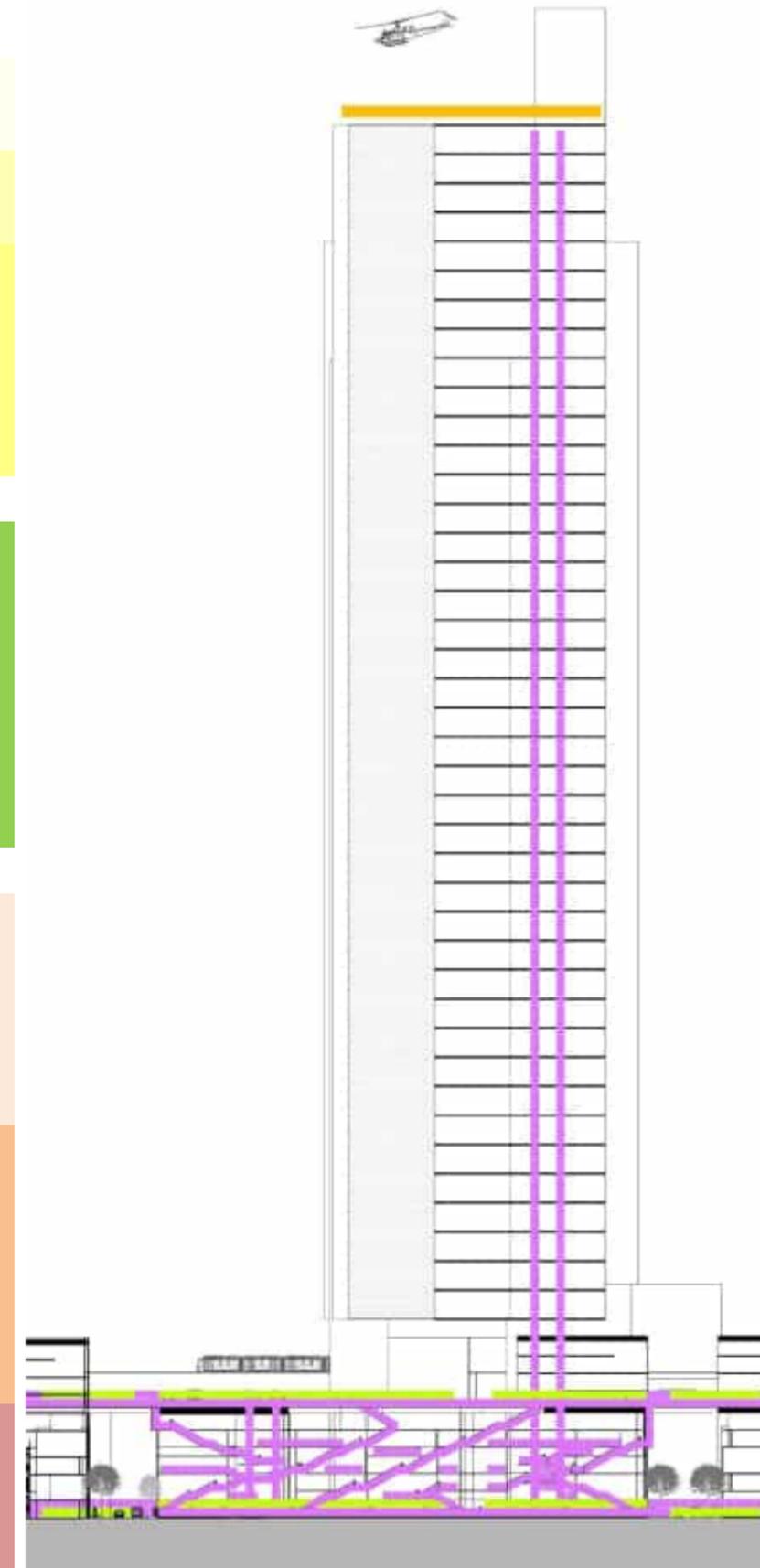
A network of public spaces



- High Rise**
- Apartments
 - Private Terraces
 - Office
 - Private amenities
 - Access atrium
 - Parking
 - Commons
 - Semipublic Terraces
 - Vertical shafts

- Flyover Connection**
- Historic Icons
 - Look outs
 - Ecoparks
 - Cultural Space
 - Bulevars
 - Education
 - Health

- New Dhravii**
- Family Home
 - Rental Residence
 - Tool house/terrace
 - Toilets
 - Outdoors work space
 - Temples
 - Sport grounds
 - Access paths
 - Local Streets,
 - Commercial avenues,
 - Vertical shafts
 - Squares
 - Local parks
 - Central spaces



Our project proposes an articulate **system of public spaces and green areas to the Mahim Creek landscape** with its mangrove ecosystem. The idea is to incorporate the natural landscape to the life of the citizens of Dharavi.

All River Front park is a continuous band bordering the river until joining Mahim Park finish it as a great lookout over the Mahim creek and view of Bandra Kurla Complex. It is a ribbon to enhance Dharavi's new skyline as seen from the north. Flyover Ground frames this natural icon by placing a band of continuous terraces along the border as part of the system public spaces. The hotels that chose this location will benefit of this beach like space, for their guests will have dedicated areas to eat and enjoy the passerby's activity.

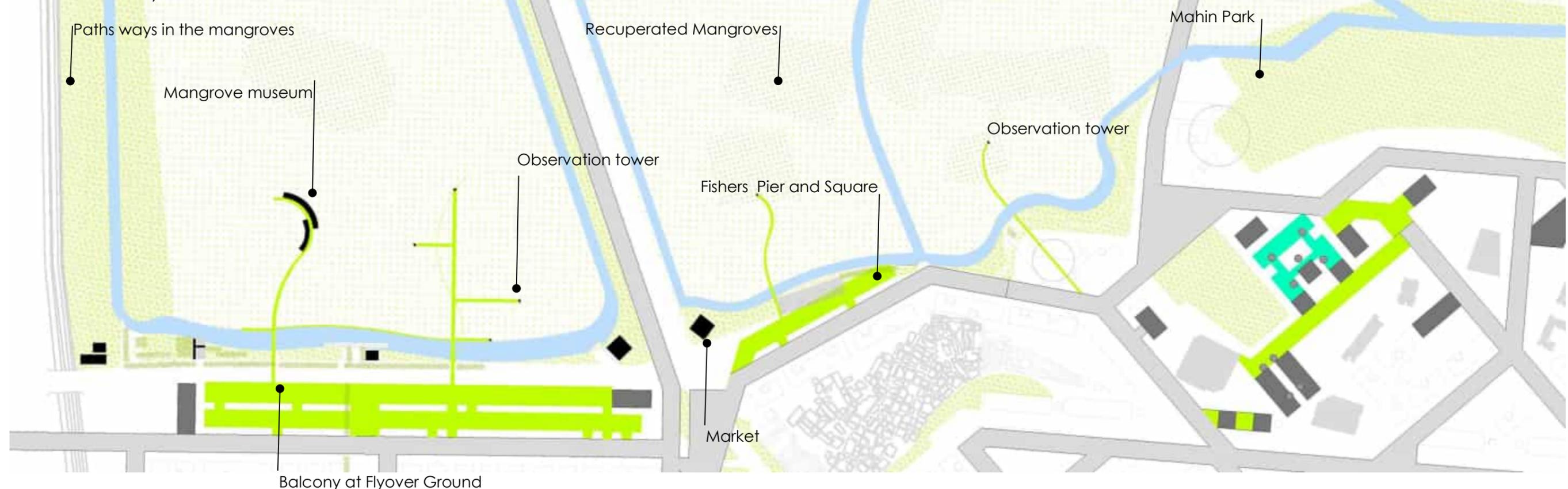
The activity program for this green band is in its relation to Dharavi's traditional livelihoods maintained over time and part of their culture.

Walkways system and bike path are developed along the Mahim Creek Park and will be accompanied by plazas, amphitheatres and gazebos. A pier provides observation towers provide original views from a high location over the mangroves to perceive vicinity of both Mithi's shores with backdrop of Mumbai's urban fabric. Programs of conservation of characteristic flora and fauna will be coordinated from these institutions jointly with tourist operators.

The Green Boulevard with its extended central Nala brings the water feature of their origins, into the heart of Dharavi, to link both of the traditional settlements (Koliwada and Kumbharwada) describing a green T with two axis stressing the location of Dharavi's first settlement. Both axes will structure the open public space system.

A Center of Study of Mangroves Habitat is proposed to support the protection of mangrove ecosystems and Forests with the support of the Museum of Mangrove and observation posts in order to oversee and monitor systematically mangrove forests and enable the development of ecotourism and environmental trails.

A reforestation program will run mangrove nurseries to help to restore the previous forest extension and use as special bio-filtering fields which will aid in diminishing industrial contamination. These activities will be integrated into schools to promote awareness of the mangrove ecosystem as a protection to the habitat of Dharavi. Good management can open new employment opportunities such as ecotourism, fishing, beekeeping and small industries of mangrove products, helping to improve local economy



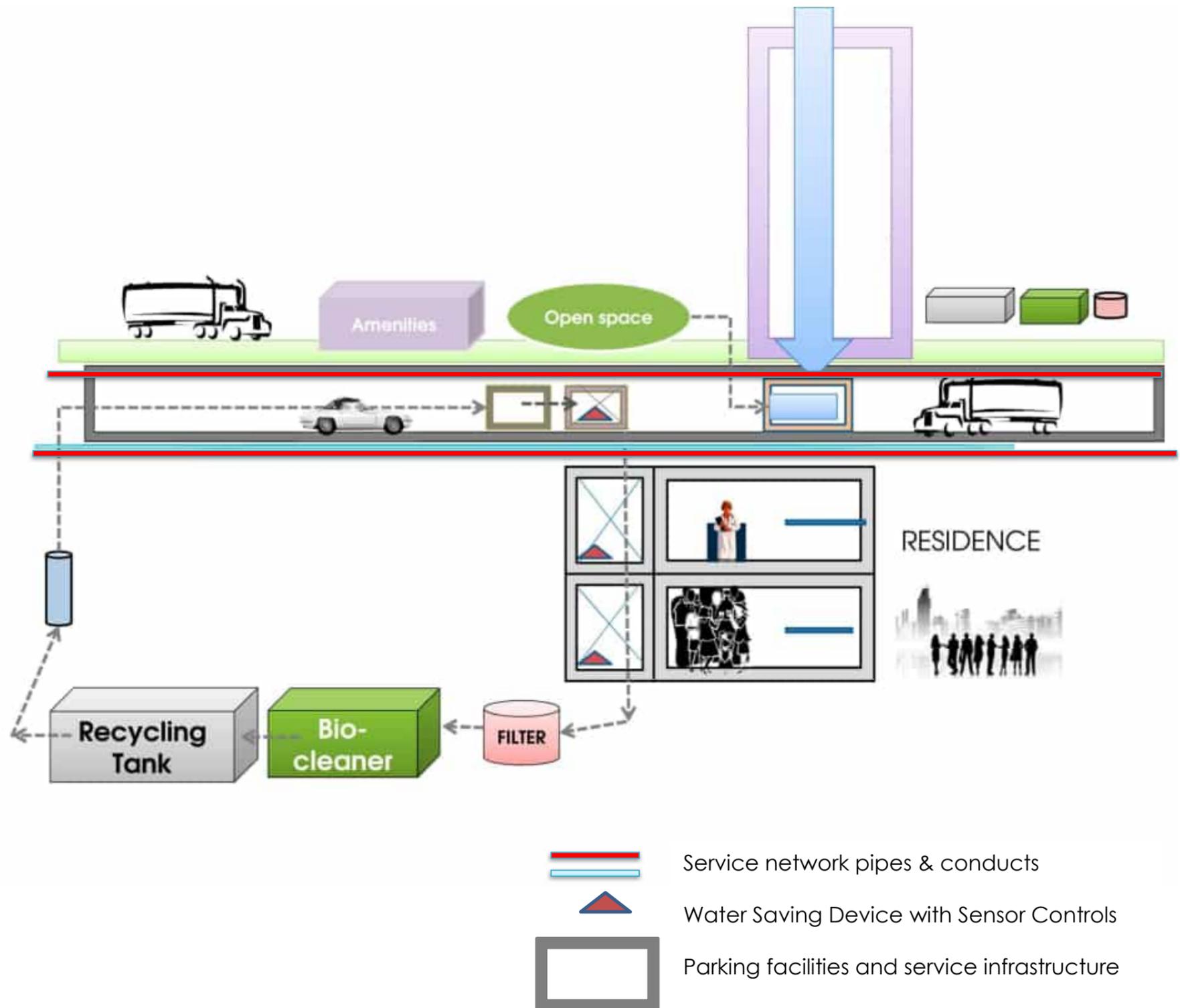
Water Management

Mumbai is facing two crises: energy and land. Due to scarce urbanized land and increasing population, lots of skyscrapers have sprawled up having tremendous power needs. **Sustainable energy architectures** can solve this problem. The tall structures generate a lot of wind and geothermal energy which can be harnessed from them using wind turbines on roof and water turbines on the ground. Wind will power the day needs, while water turbines will run the pump to carry water. Also solar powered cells to harness electricity for daily use and provision for collecting of rain water.

These technologies will be required to Developer Groups selected for Dharavi' s process:

- Smart building operating strategies
- Active building envelope systems and passive solar technologies.
- To achieve zero average annual energy consumption at both the building and neighborhood levels through combinations of passive systems and dynamic building envelope technologies.
- This includes building-integrated solar systems and high-performance windows with active control of solar gains, short-term and seasonal thermal storage, combined cooling and power technologies, and smart controls.

The panoramic for Mumbai's commodities must change radically and Dharavi should set a trend for self-sufficient neighborhoods. Huge cities will not continue depending on the ever increasing complexity of citywide networks, but instead foster independent local networks to produce enough power and other resources for internal use and even sell out surplus production to other communities.





Nala Network



Through time the Nalas (channels) Network has been filled to gain space, resulting a poorly drained surface with high flood risk.

The proposal include expanding the channels and building 5.300 additional m. That will improve storm water drains shortening spans to final disposition of superficial runoff, and remediate floods affecting the border bands . The nala network will have multiple communication to Mithi improving speed of its current and natural spaces.

Correctly designed it might be a sufficiently reservoir of water in dry seasons and enhancing feature of green spaces and natural cooling system

Waste disposal

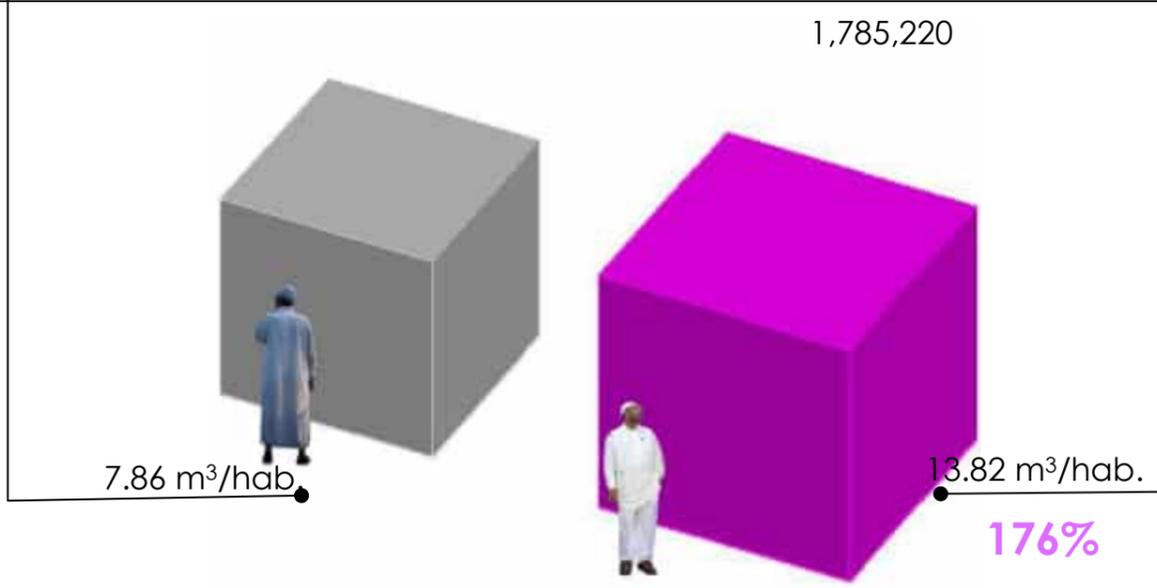


Our smart city proposes the use of an automated vacuum waste collection system, which transports waste at high speed through underground pneumatic tubes to a collection station where it is compacted and sealed in containers. The system helps facilitate separation and recycling of waste.

The process begins with the deposit of trash into portholes, which may be specialized for waste, recycling, or compost. They are located in public areas and private properties. The waste is then pulled through the underground tunnel by air pressure difference created by large industrial fans. The pipelines converge on a central processing facility that uses automated software to direct the waste to the proper container, from there to be trucked to its final location, such as a landfill or composting plant.

As it is mandatory to provide housing for all already living in Dharavi, and because of financial reasons is also inevitable to bring new people to the land, **dropping the density while maintaining the inhabitants** sounds like a contradiction. It is possible, however, if like all components of the proposal, the density is considered in 3d. Currently, the constructions, although hugely dense, occupy the land very near the only ground. Introducing new grounds, and open air between them, actually gives more space to each inhabitant:

Uses	Existing		Proposed for substitution						What it is got?	Proposed for Rent		Total Area
	Area (m ²)	Volume (m ³)	New Dharavi		Flyover (*)		Total			Flyover(*) (m ²)	High Rise (m ²)	
Amenities	45,505	136,515	41,027	123,081	179,678	898,388	220,705	1,021,469	161%	119,785		340,490
Houses	849,646	2,548,937	64,204	192,612			64,204	192,612				64,204
Commercial+ Mixed	544,144	1,632,431	40,462	121,387			40,462	121,387				40,462
Residential Buildings	1,148,622	3,445,867	105,570	316,711			105,570	316,711				105,570
Residential Units			2,917,172	10,939,397			2,917,172	10,939,397				2,917,172
Toilets -Tanks	14,058	42,175	343,338	1,030,014			343,338	1,030,014	2442%			343,338
Temples	18,118	54,353	69,437	208,310			69,437	208,310				69,437
Total Living/Work	2,620,092	7,860,277					3,760,888	13,829,900	175%			3,760,888
Industrial												
Parking	36,391	109,174					94,226	192,612	258%			94,226
Corporate					350,061		350,061	700,121		350,061	2,958,790	2,958,791
Green Areas	251,927		387,796		93,707		481,503			65,439		518,674
Street	1,359,978		360,405		238,571		598,976			238,571		837,548
Semi-public open areas			705,255		27,753		733,009			27,753		760,762
Total Open/Public	1,611,905						1,785,220		112%			



The construction ceiling, in our proposal, could reach 10 times Dharavi's floor area. Frame Project can adapt to special factors: volume of infrastructure to cross-subsidize at the time of launching redevelopment, or sectorial demands of market, whether it is oriented to tourism or corporate real estate. This will provide necessary flexibility to stretch to financial desires

(*) As the facilities in the Flyover Ground should be shared for everybody, it was considered that 60% goes to current occupants, the rest to the new uses.

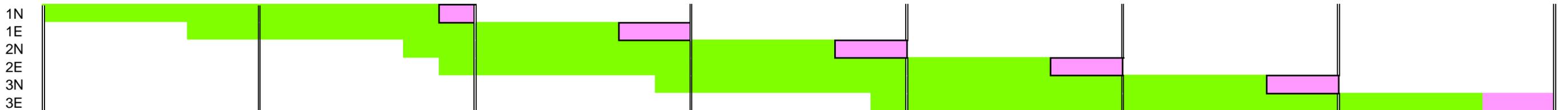
Two lots have been identified as soft construction/use and potential spark to the **construction process** without disrupting common activities. The north plot, currently used as Bus Depot must be moved to its new location on Sion Train Station grounds. The other plot located north of the Mahin Station (2.4 has) has no important uses and land is property of Maharashtra Railroad.

These two lots will be used to build first compounds initiating the proposed grid.

Without
Transition camps



The first stages must set example which will affect communities in deciding to participate, will decide upon the positive experience of first communities to receive new homes and how they can customize by participating in the process. When they receive their new houses, the next construction stage will implement a new construction site on vacated land in order to replicate the process six more times on both fronts while enlarging the size of next stage as much as possible. The whole scheme will be complete, in approximately 15 years.



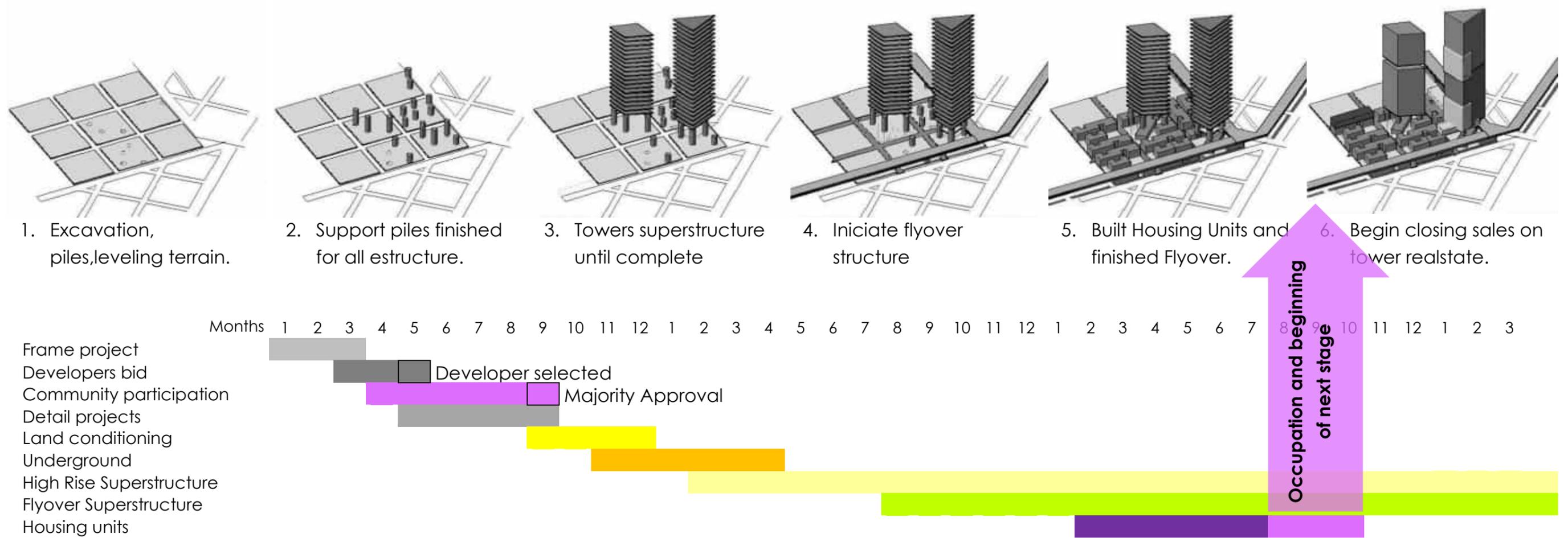
A long period of initiatives, made people suspicious of redevelopment. This proposal must be thoughtfully promoted to Dharavies, in discussions, and charrettes to evaluate the expectations, producing drawings, sketches and home types. Reaching a million busy people is a challenge, so it's important to design a fresh start, to win the heart of a majority.

Once impulse is gained, an important issue is **avoiding disruption of normal activities** in Dharavi. It will take a decade to improve Dharavi to everyone's satisfaction: dwellers, finance and government sectors. Developers will stretch efforts not to disturb the area, by planning in detail: alternate ways, entrances, cargo and materials and safety measures, supervision of locals who'll have voice to management board, through their elected leaders.

An **Autonomous Smart Management Unit** is activated with community, government and construction management as partners. This body should be flexible enough to tackle the construction problems but strong enough to have the ears of city's authorities in coordination of general utilities network: power, sewage, water supply, provisional measures, etc. SMU prepares a bidding process for one of the Financial Units. The recipient communities are chosen from the neighborhood to protect social nets.

Projects will remain in open discussion until **the construction work starts**. Community will be called to supply the services, for construction and upgrading of their homes offered. Check points and approvals will be required of **Investor Group** by corresponding urban authorities .

The facilities of Unit will be open to community and representatives, hosting all type of divulgating/consultation gatherings and activities, offering work space and professional assistance to discuss alternative plans until the majority is satisfied. Project related and activities schedule will be public.



Smart Dharavi Foundation

is a nonprofit organization created exclusively for the purpose of executing, from planning, the Smart Dharavi Project, assign responsible for the final design, coordinate responsibilities for the implementation, monitoring compliance with the standards established quality and create the legal framework for delivery infrastructures to local governments, investors and residents of Dharavi.

Dharavi Smart Foundation will become the Smart **Dharavi County** in charge of maintenance and security of the Mayor.

This body should have ministerial rank reporting their activities directly to the Cabinet Secretary and count your directory with members of the executive ministries involved, representatives of the community of Dharavi and investors of the city of Mumbai.

Through its Technical Department is the agency responsible for the overall project completion and finish Functional Descriptive Report will serve as a guideline for specific designers of different "stages" calls to international competition by establishing delivery requirements.

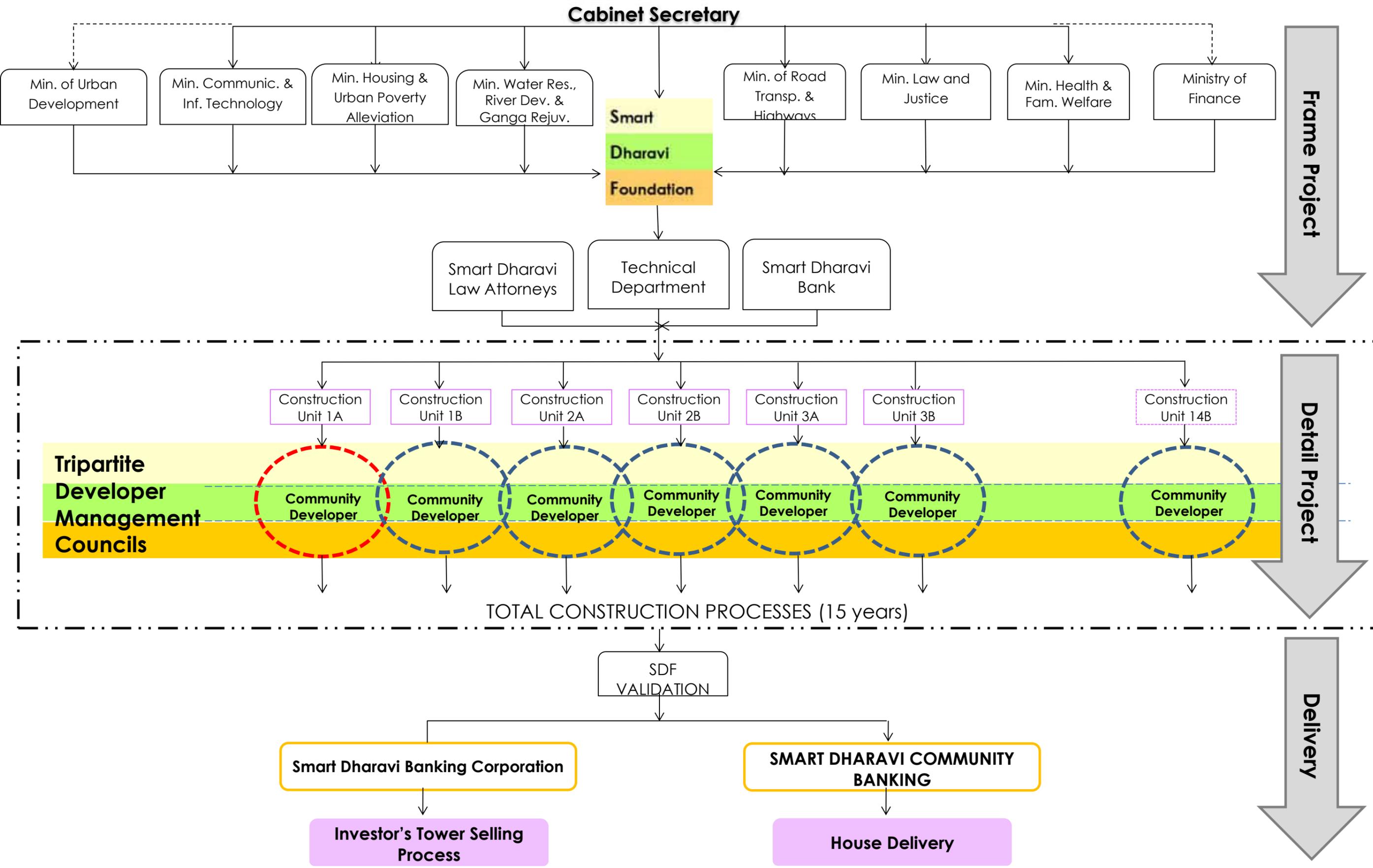
- Compile results and do errands for all proposals meshing properly in the project matrix checking the compatibility of parts
- Once consolidated the various developments of the 14 stages, call for tender competition to deliver the performance of the work to developers-investors.
- Ensure the implementation of the project and through its project department, inspect the work is executed to meet the stated parameters.
- Giving the final approval for Developers to begin the marketing of the towers.
- Through the MCIT, aggressive advertising campaigns (depending on the stage at which the project is located) at regional, national and international levels for the promotion and dissemination of the project with national impact and as a state policy to be designed modernization of India.
- Coordinate the work of the Smart Dharavi Law Attorneys and Smart Dharavi Bank
- Teaming with local governments of Maharashtra and Mumbai to coordinate transformation into Smart Dharavi County for creating mayoral agencies and the collection and allocation of funds for them.

Smart Dharavi Law Attorneys

- Establish whole legal foundation and preparation of all legal documents for the future delivery of land and sale of housing units to be built in Smart Dharavi
- Formalize the supply of housing units current Dharavi to prevent its occupation after delivery of the new units.
- Coordinate necessary legal framework throughout the project, including specific clauses for each Stage and Financial Unit.
- Establish and define the legal parameters for negotiations, in accordance with the applicable laws in India concerning the purchase and sale of property, and the contract terms.

Smart Dharavi Bank will operate through 2 subordinate bodies: the Smart Dharavi Banking Corporation (SDBC) for dealing with corporate developers and Smart Dharavi Community Banking (SDCB) for dealing with Dharavi actual dwellers:

- Will establish detailed financial legal parameters concerning the reception of the structures developed in each Financial Unit (through the SDBC) and the allocation of housing (through SDCB) .
- Will be responsible for the delivery and the establishment of conditions of sale of units of the new inhabitants of Smart Dharavi.



As Smart Dharavi was conceived to work in 3d, all grounds together, the fractioning for construction should contain components in each ground to be assigned to a specific investor and a particular community. These parts are the **Financial Units**. The units are not all identical as they should respond to its specific location in the global map. but do are equivalent, as they should all have a fair share in the expenses for the construction cost.

Here an example of one of the many possible financial units:

As is explained below:
 Index Construction cost US\$

		Area (m ²)	Total (m ²)	Index	Construction cost US\$
New Dharavi Ground	Street Block	5	24,862.86	1.15	42,940,078.03
	Courtyard Block	1	24,862.86	1.15	8,588,015.61
	Square Block	2	20,825.24	1.15	14,386,718.67
		8			190,827.64
	Open area			0.70	3,406,096.55
	Streets			1.25	825,993.43
			209,227.64	17.73%	70,146,902.29
					6.46%

+

		Area (m ²)	Total (m ²)	Index	Construction cost US\$
Flyover Ground	Street Block	5	5,031.00	2.20	16,622,291.82
	Courtyard Block	1	4,533.38	2.2	2,995,635.00
	Square Block	2	4,140.76	2.2	5,472,390.19
		8			37,969.91
	Amenities			2.35	28,233,957.31
	Flyover Streets			7.2	54,065,024.63
	Public Space			1.75	16,820,229.89
			134,969.91	12.20%	124,209,528.84
				12.33%	

+

		Area (m ²)	Total (m ²)	Index	Construction cost US\$
High Rise Ground	Void Tower	1	73,097.60	3.55	241,125,510.07
	Triangular Tower	3	75,378.88	3.55	77,942,690.84
	Central tower 1	1	255,470.84	3.55	272,404,062.79
	Central Tower 2	1	186,433.99	3.55	198,791,285.27
	Long Tower	1	4,427.86	3.55	100,686,763.78
		7			762,469.30
				68.90%	890,950,312.74
				80.71%	

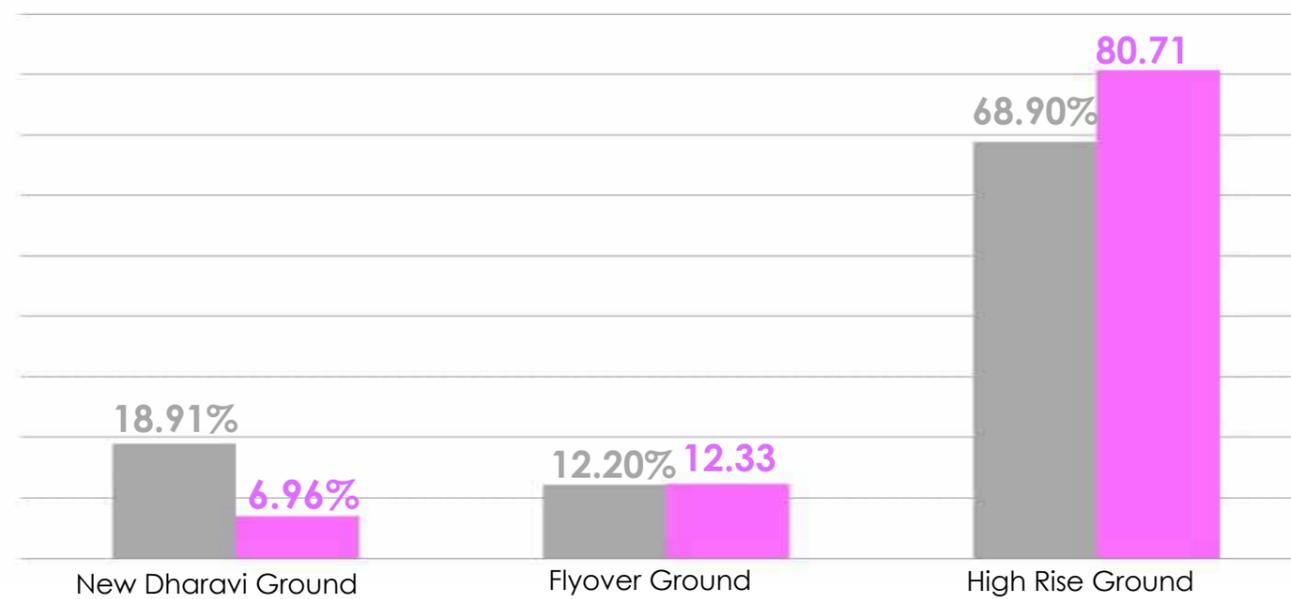
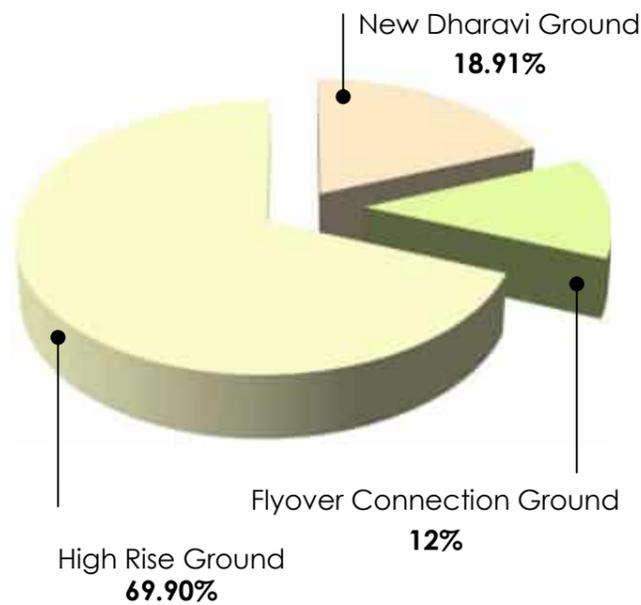
To **estimate the cost** of such a complex construction, involving so many types of different structures is not evident Here some precisions on how the cost were calculated:

	RS/sqft	US\$/m ²
Average	2,300.00	406.37
Minimun	1,700.00	300.36
Sell Corporate	12,500.00	2,208.54

Consolidating the estimates of construction cost in Mumbai we find a value of 1,700 Rs/sqft as the minimum cost of construction and 2,300 Rs/sqft as the average cost of construction. Similarly it seems reasonable to estimate the selling price on financial towers at 12,500 Rs/sqft.

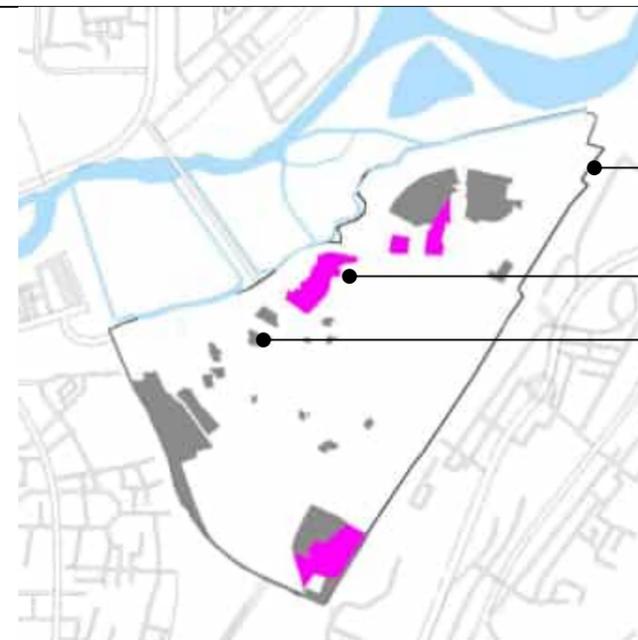
Minimum construction cost multiplied by an "index" allows estimating the cost of construction for each element. Thus it was determined that the blocks can be built for the minimum cost multiplied by a factor of 1.15 , public areas in Dharavi New Ground by 0.70, the streets of the same ground by 1.25 by 3.55 towers and so on ...

As validation of financial scheme, the relative weight of construction on the total was estimated, obtaining 68.9% of the total for High Rise (particularly healthy because it will be from this sale where profitability will be obtained.



The consistency to the estimates can be seen in the graph comparing the **cost** of each ground compared with their total **construction area**.

Additionally, other cost should be estimated: **the value of land in private ownership** with title. These lands should be bought from their owners (even by legal expropriation) but others, holding constructions to be preserved, or in hands of multiple owners are being respected and are inserted into the grid New Dharavi. The land value was estimated in 4188 US\$/m² (1)



Total Dharavi	2,394,923 m ²
Total Private Land	372,190 m ²
Land to remain private	102,282 m ²
Land to be purchased	269,908 m ² 11.27%

Cost of land 1,130,438,216 US\$

The cost of each Financial Unit has components in each ground, and a share of the cost of the land that should be purchased. There are 150 block in the proposal, so the cost of the land was divided among 19 Financial Units:

New Dharavi Ground 70,146,902.29	+	Flyover Ground 124,209,528.84	+	High Rise Ground 813,007,621.90	+	Purchase Land 59,496,748.26	=	Total 1,066,860,801.29
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The **flow chart of construction** for each unit, for a three years period is not homogeneous. It was estimated it will be necessary to start land acquisition, removal, piloting and begin construction of the shafts 35% of the total in the first quarter of the work, leaving for the remaining quarters proportions of low single digits. We are aware this calculating method, further raises construction costs since the most of the loan money will be needed at the start. Annual rate of interest of 5.5 % (also high) is estimated with an additional 1.25 % to be delivered to the Smart Dharavi Foundation through Smart Banking Corporation for operating expenses.

Quarters	%	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th
% Used Capital		35%	12%	12%	6%	5%	3%	3%	4%	5%	5%	5%	5%
Used Capital (MM US\$)		373.40	128.02	128.02	64.01	53.34	32.01	32.01	42.67	53.34	53.34	53.34	53.34
Cumulative Capital			501.42	629.45	693.46	746.80	778.81	810.81	853.49	906.83	960.17	1,013.52	1,066.86
Yearly Bank Interest	5.50%		5.13	6.89	8.65	9.54	10.27	10.71	11.15	11.74	12.47	13.20	13.94
Yearly Smart Dharavi Foundation Interest	1.25%		1.17	0.40	0.40	0.20	0.17	0.10	0.10	0.13	0.17	0.17	0.17

3 years Rentability 112.84%

The **total cash flow** of the Smart Dharavi Foundation along the complete construction process, expressed in million US \$:

Year	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th
Stages															
E1 - N1	4.33	1.00	1.33												
E2 - N2			4.33	1.00	1.33										
E3 - N3				4.33	1.00	1.33									
E4 - N4					4.33	1.00	1.33								
E5 - N5						4.33	1.00	1.33							
E6 - N6							4.33	1.00	1.33						
E7 - N7								4.33	1.00	1.33					
	4.33	1.00	5.67	1.00	5.67	1.00	5.67	1.00	5.67	1.00	5.67	1.00	5.67	1.00	1.33
															46.68