

PROPOSED RATING SYSTEM FOR COMMERCIAL COMPLEXES IN AHMEDABAD, GUJARAT ,INDIA

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Proposed Rating system for Commercial Complexes,
AHMEDABAD,INDIA

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CERTIFICATION PROCESS:

The certification is a formal process which will validate that the commercial project has achieved the environmental performance specified in the rating system. Evidence of compliance of each credit rating would be documentations that would be submitted to fulfil each.

The certification will happen in two stages:

1. Provisional
2. Complete

The provisional certificate has to be applied for within 4 weeks of commencement of design and it would be awarded once the design stage of a project is complete.

This level of certification will only ensure that the project has all the required strategies and requirements needed to achieve sustainability.

It will be valid for a maximum of 3 years, or till completion of construction of the project, whichever comes first.

The complete certification is necessary to obtain if project wants to be deemed as a green building, when its construction is completed.

This level of certification will ensure that the building or project is performing as it is designed to be, and as such, should be re-certified every five years.

Awarding of points at this stage is flexible, points awarded during the provisional certification may be lost, or vice versa.

Where the construction or installation differs from that which is specified within the Provisional Certification, projects must justify how these changes provide an equal or greater environmental benefit for the points to be awarded (LOTUS, 2015).

PHASE OF COMPLETION	CERTIFICATION
DESIGN COMPLETION STAGE	Provisional
PROJECT COMPLETION	Complete
RATING	REQUIRED POINTS
SILVER	30
GOLD	45
PLATINUM	55-60

PROPOSED RATING SYSTEM FOR COMMERCIAL COMPLEXES AHMEDABAD, GUJARAT, INDIA

With the way the city is urbanising, and looking at how fast it is growing, the city officials have constructed a development plan for the next 25 years, which will then get revised for the coming 25 years. These plans provide for all the land uses that are needed to economically and socially sustain a city, like residential zones, commercial spaces, industries, recreation and transport. To accompany the development report, we are formulating energy sustainability guidelines. Due to the huge scope of the report, we are restricting our work to just commercial complexes.

Commercial complexes are basically integration of retail spaces, office spaces, convenience stores, godowns/ warehouses. They are generally located in areas with high population density and are currently the trend in Gujarat, specifically Ahmedabad, as they also incorporate public open spaces for the recreational purposes of the users.

Gujarat Development Control Regulations (GDCR), by Ahmedabad Urban Development Authority (AUDA) give the following definitions for:

1. Mercantile building or a commercial complex means a building or part thereof used as shops, stores or markets, for display and sale of wholesale or retail goods or merchandise, facilities incidental thereto located in the same building.
2. A developer means the person who is legally empowered to construct or to execute work on a building unit, building or structure, or where no person is empowered, the owner of the building unit, building or structure.

AHMEDABAD: City Profile and Documentation

This bustling city is located on the banks of the Sabarmati River. It was built by the then Emperor Ahmed Shah some 600 years ago. It is a major economic and industrial hub for the state of Gujarat, and one of the fastest urbanizing cities in India. It also enjoys a lot of cultural significance, with respect to its old city textile mills and the river running through it.

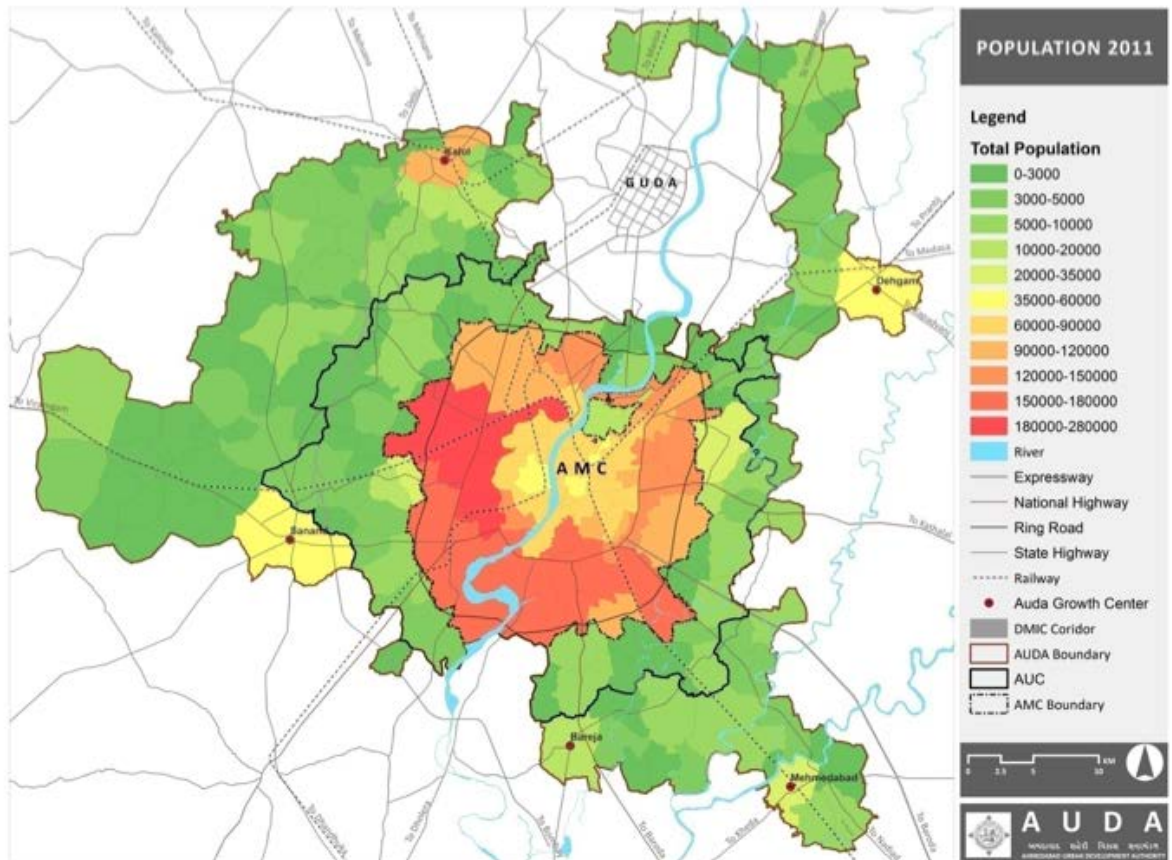


Figure 1: Demography, Draft development plan 2021, Embarq India

Existing Condition:

Population: 5577940¹

Density: 11948/sq km²

These maps are a function of population on the city plan. The city boundary is ever growing. New places keep on falling under the jurisdiction of Ahmedabad Urban Development Authority (AUDA) whenever the city's development plan is drafted. Majority of the population is concentrated in the city proper, the area near to old city, and the commercial and central business districts found in the city. We can better appreciate the density of people from the map/ diagram shown below.

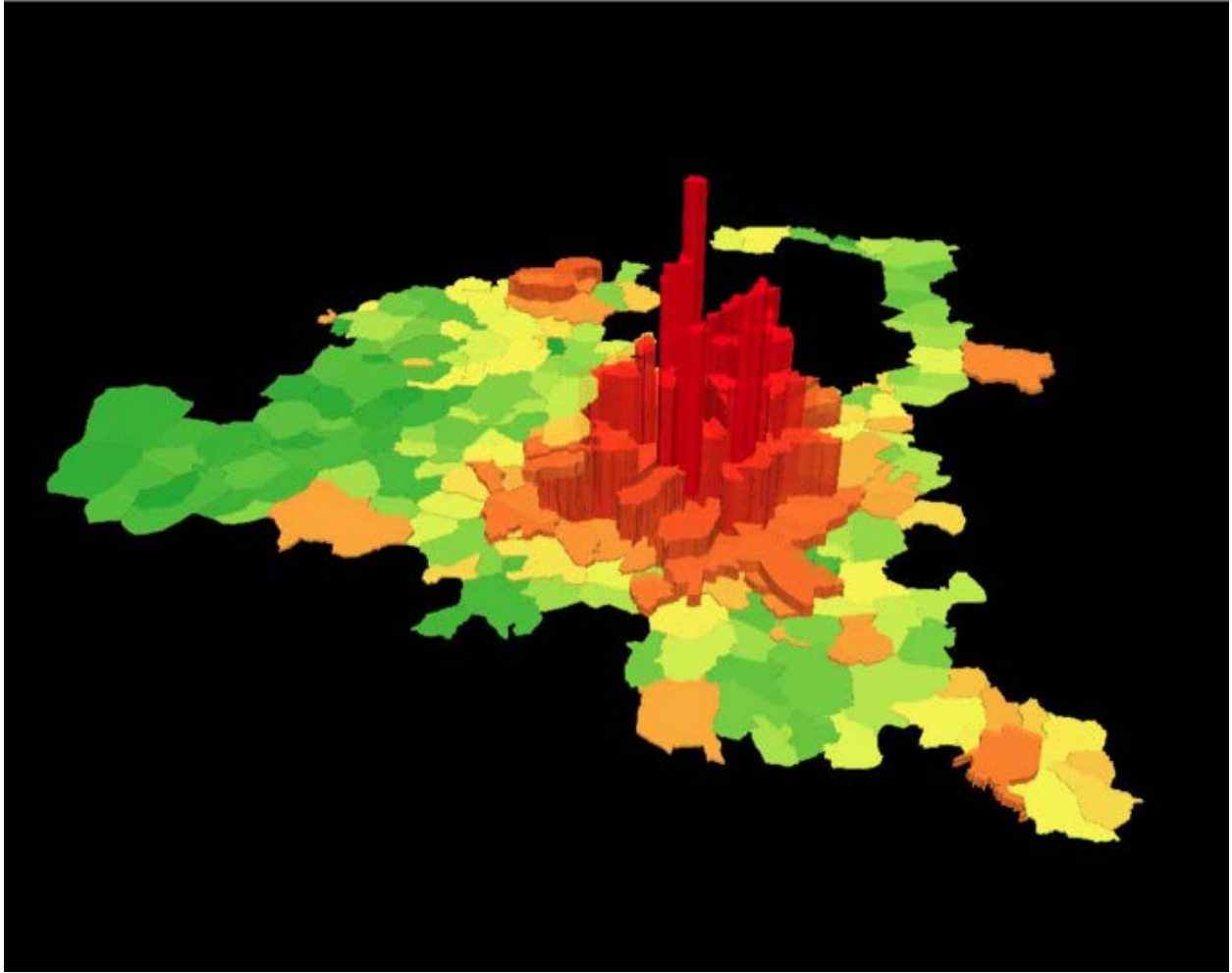


Figure 2: Population Density of Ahmedabad, Draft development plan 2021, Embarq India

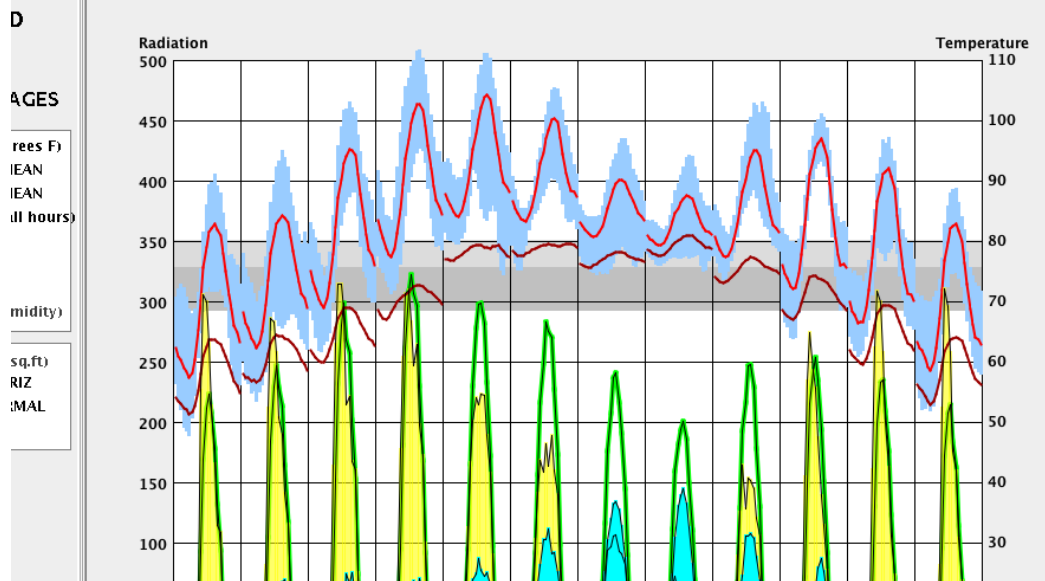
Embarq India, in its presentation on the second (revised) draft development plan 2021 estimates that the gross density of Ahmedabad stands at 122 people per hectare, surprisingly falling just below Shanghai. For a projected population of about 80 lakh in 2021, the report has estimated a need of additional 184 Sq. M. of land to ensure the urban carrying capacity of the city is not compromised. A major chunk of this new land will go for commercial activities. Hence it becomes very important to formulate guidelines to ensure that commercial activity does not, in effect, 'boom' in an unplanned way.

Climate:

Ahmedabad experiences a hot climate, with humidity in the summer months, especially July and August. Temperature usually reaches beyond 110°F in the summers during the day time, and hardly ever goes below 50°F in winters. Annual average rainfall (calculated for the years 2000-2012 in the chart obtained from the world weather online website) is around 300 mm.

CLIMATICAL AVERAGES
 Standard 55-2004 using PMV

LOCATION: Ahmedabad, Gujarat, IND
 Latitude/Longitude: 23.07° North, 72.63° East, Time Zone from Greenwich 5
 Data Source: ISHRAE 426470 WMO Station Number, Elevation 180 ft



Average Rainfall (mm Graph for Ahmedabad)

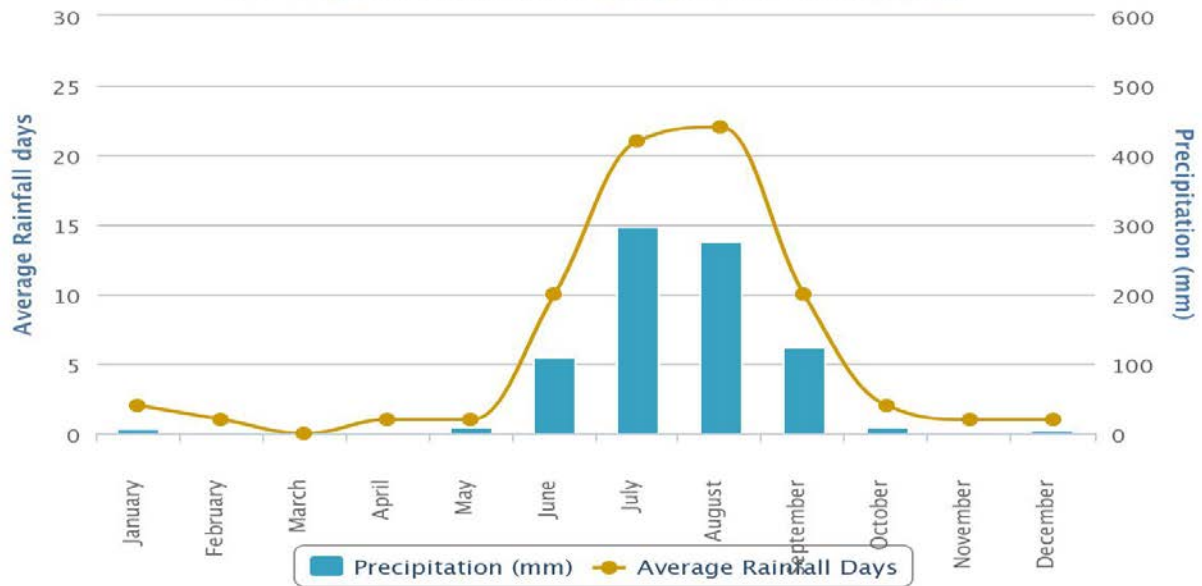


Figure 3,4: Average rainfall, taken from worldweatheronline.com

Land Use:

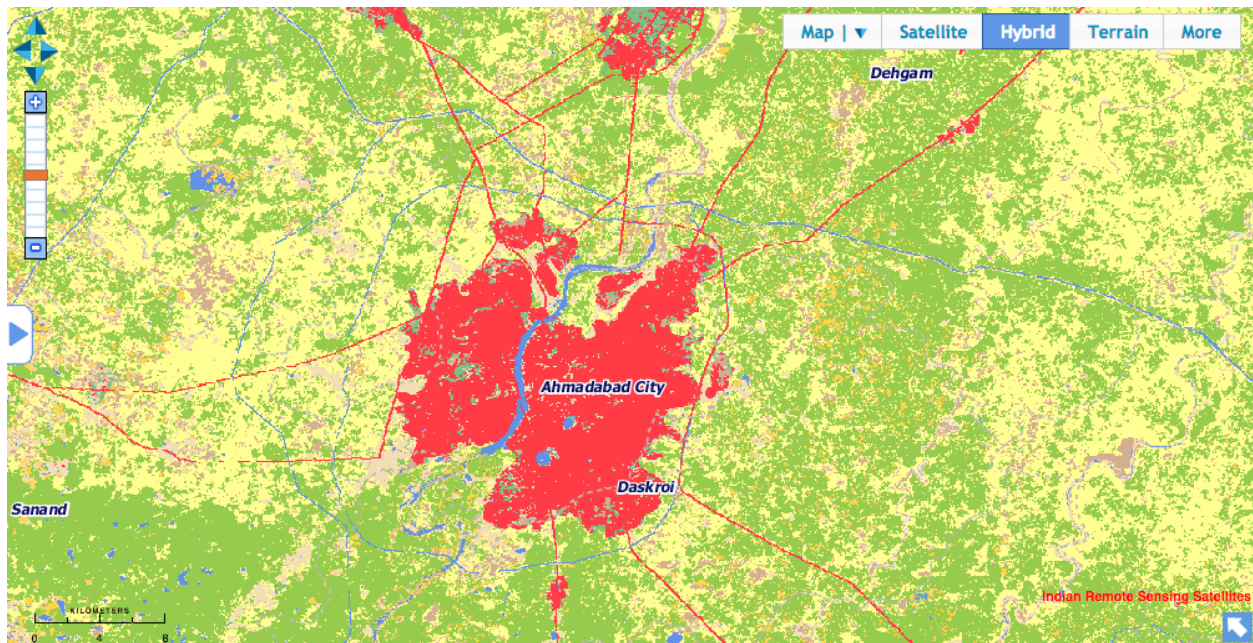


Figure 5: Land use pattern 2004-05

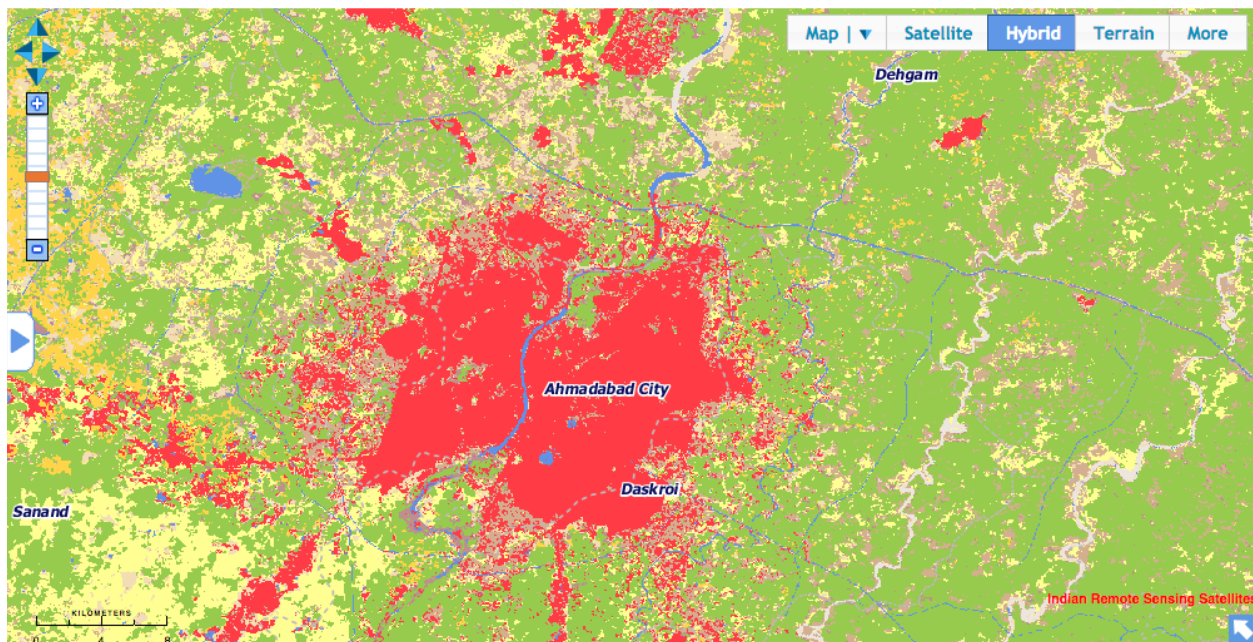
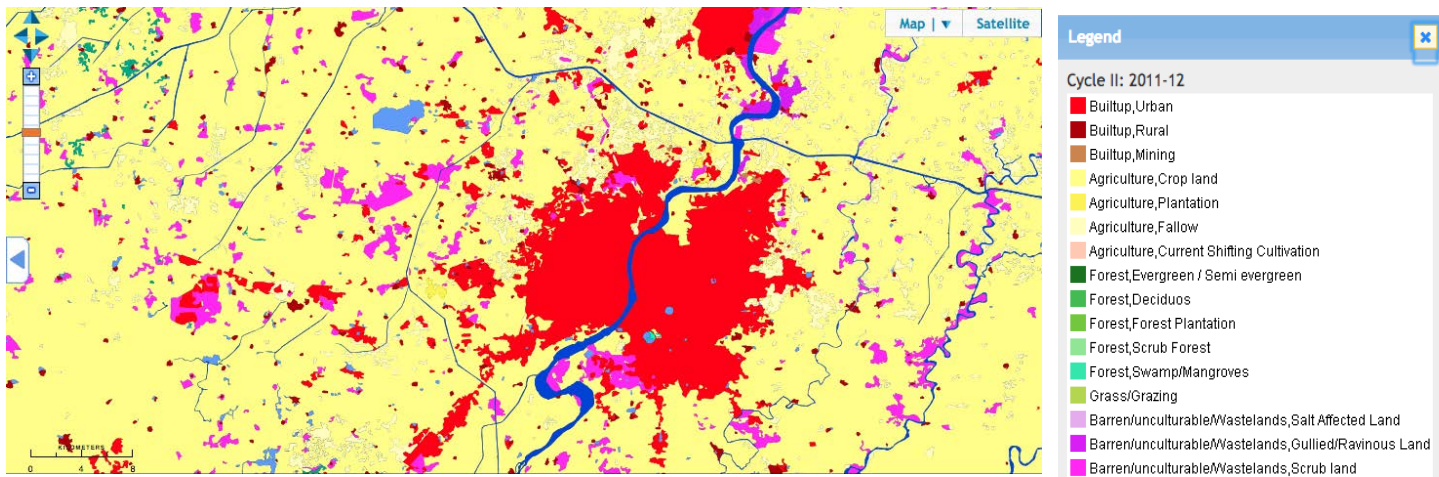


Figure 6: Land Use pattern 2013-14

The above two maps show how the city has sprawled in the past decade. Where it was limited to around both sides of the river in 2004-05, by 2014 development has basically “leap frogged” to



the surrounding farmlands.
Figure 7: Present Land Use

Transport/ Connectivity:



Figure 8: Street design - BRTS corridor

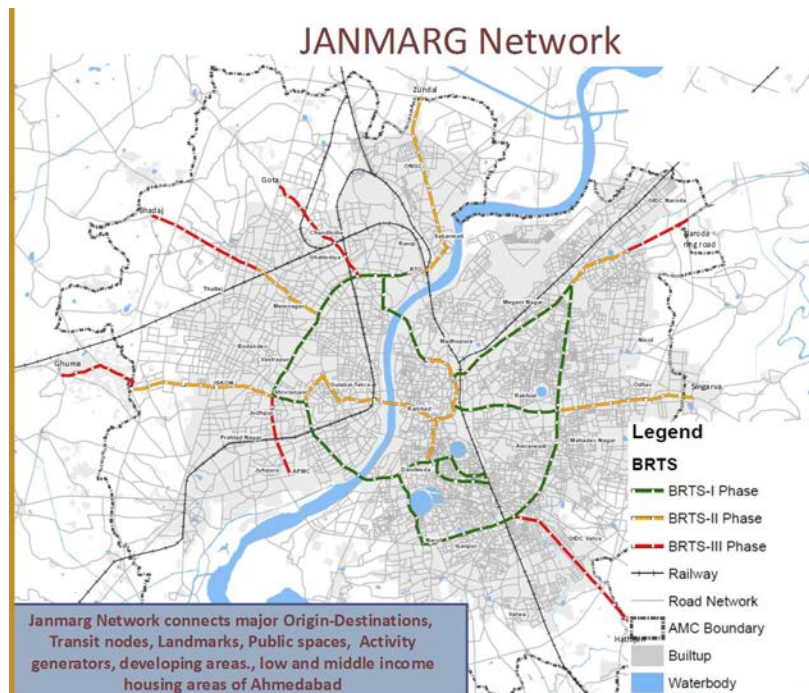
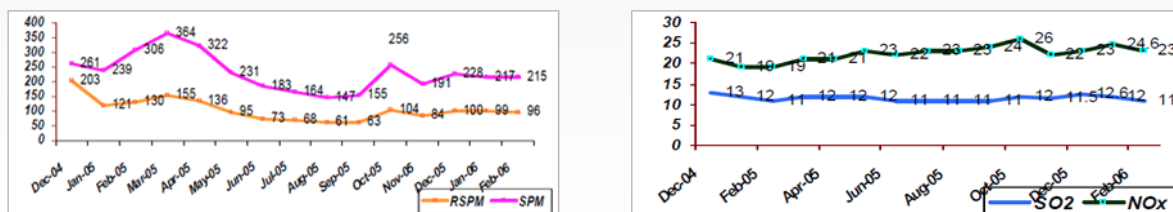


Figure 9: BRTS corridor, obtained from PM Modi's website

Ahmedabad enjoys good intracity connectivity via road. The bus rapid transit system is specially popular and successful here. This transit mode was envisaged to give importance to public transport, non motorised vehicles and walking/ biking, with pedestrians enjoying dedicated lanes for them. The system is supported with prolific use of Intelligent Transport Systems. One point to note is that not every crossing or patch of route enjoys the facilities shown in the above photograph, at present.

Air Quality:

Ambient air quality of Ahmedabad is polluted. Gujarat Pollution Control Board has 14 stations in and around the city, which records the air quality [3].



Results are expressed in microgram per normal cubic meter

Figure 10: Air quality

CREDIT LIST INDEX:

	Categories	Description	Points	Pg No
LT	Location, Transport			12
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LT3	Street design	Inclusion of the streets in building	2	17
SS	Sustainable Sites			19
PR	Environmentally Assessed Site	Environmental Impact assessment reports mandatory	Pre req	21
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SS2	Land reuse	Utilization of vacant land in city	2	23
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SS4	Rainwater Management	Rainwater harvesting management	2	26
W	Water			28
PR	Documentation of existing water supply and disposal	Pre-req to qualify for this category	Pre req	31
W1	Maintenance of Water systems	Water efficient systems Augmentation of natural water resources	2	32
W2	Water Audit	Central monitoring systems Reduction in water use	2	33
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EA	Energy, Atmosphere			37
PR1	Commissioning energy efficient methods and	Use of passive architecture to reduce cooling and heating loads	Pre req	39

	implementing passive design			
EA1	Renewable Energy Use	Promoting renewable sources of energy	2	40
EA2	Energy Metering and Documentation	Improve energy benchmark	3	41
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EA4	Discontinuing use of refrigerants	To discourage use of CFC's in refrigerants.	2	43
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MR1	Materials made with recycled products factory by	Using flyash in major building materials as component.	5	49
MR2	Construction and Demolition waste management	Promoting recycling/ salvaging of building materials	2	51
MR3	Life cycle cost impact reduction	Promoting use of LCA to help choose materials	5	52
EQ	Indoor Environment Quality			54
PR	No indoor smoking	Pre-req to qualify for this category	Pre req	59
EQ1	Indoor Air Quality	Fresh air supply Ventilation Carbon Dioxide monitoring Air Filtration	3	60
EQ2	Indoor Thermal Comfort Levels	Temperature control for the occupants at required timings.	2	61
EQ3	Indoor Visual/ Comfort Levels	'Access to nature' as a stress reliever.	3	62
EQ4	Indoor Acoustic Comfort Levels	Noise prevention strategies	1	64
EQ3	Hazardous Materials	To discourage use of volatile organic compounds, that would adversely affect human health	3	65

LOCATION AND TRANSPORTATION

CATEGORY 1: Location and Transportation (8 POINTS)

IDENTIFICATION OF ISSUES:

1. Linking commercial centers to the public transport network
2. Using the base transit system as a feeder for the existing BRTS
3. Encouraging walkability and non motorised transport
4. 'Model' street layouts to facilitate public space
5. Integrating existing infrastructure in new development

OVERVIEW

The Location and Transportation (LT) category awards those projects which take into account location and siting, with respect to physical and social infrastructure. The credits for this particular category “encourage compact development, alternative transportation, and connection with amenities, such as restaurants and parks”. The main criteria for being judged for the LT category is how well the project integrates available amenities (like gas, water, electricity) and infrastructure to their development. In turn, it also allows the focus to be on “how this infrastructure affects occupants’ behavior and environmental performance”[A]. So, urban transit modes, walkability, bicycle paths and other street networks are the major actors. This will enable the users to shift from private vehicles to other, more ecological friendly modes of transport. Bicycle racks/ parking areas will promote cycling, along with pedestrian movement. Charging/ fuel stations for green vehicles will promote users who are interested in these modes.

“Walking distances must be measured along infrastructure that is safe and comfortable for pedestrian: sidewalks, all-weather-surface footpaths, crosswalks, or equivalent pedestrian facilities.”[A]

“As per IPCC, nearly 30 per cent of the global GHG emissions are contributed by the transport sector.” It is no different in India. It contributes about 10 per cent of the energy related GHG emissions in the country. Urban areas are experiencing an unprecedented growth rate in personal motor vehicles. This gives rise to problems of congestion, air pollution and more worryingly, road accidents. Not many people choose to take the public transit, nor do they like to walk or bicycle. It becomes necessary to shift /retain people to these clean modes of transport and discourage them from using private vehicles as far as possible. The Location and transportation category can help in achieving this motive. Circulation networks in and around new developments should promote walking and cycling for trips. Collective transport services should be provided to meet mobility demand within the development and provide connectivity to the nearest public transit stops. Innovative design and pricing measures should be employed to promote sustainable mobility modes and create an enabling environment for safe as well as secure mobility for all [B].

CREDITS:

LT	CREDIT	Description	Points
LT1	Public Transit Linkages	Easy accessibility	3
LT2	Promotion of non-motorised transit	Encouraging bicycle use and pedestrianisation	3
LT3	Street design	Inclusion of the streets in building	2

LT1: Public transit Linkages**Intent:**

To connect the users of commercial buildings way to nearest existing transit system in order to ensure less use of private vehicles and encourage use of public transport.

Requirements:

Criteria	Points
Location of entry not more than 800 meters from nearest transit stop	1
The compliant public transport node must be connected to a local urban centre, on the working days. Compliant node: any bus stop, railway, tram or underground station, measured from the building entrance via a safe pedestrian route . The service stopping at each node must provide transport from, or onward travel to, either a local urban centre, major transport node or a community focal point e.g. doctor's surgery, library, school or village centre. [F] If there are two or more stops near the building within less than 800m radius and are part of the same transport system, then the closest one should be taken into consideration.	1
Within 200 metre radius along the BRTS/Metro transit corridor one can construct buildings of up to 4 FSI [G].	1

Behind the Intent:

If the users are in proximity with the public transport, it would definitely increase the use of the commercial complex as it would become more easily accessible. Also, net reduction in pollution by restricting the use of private vehicles helps to conserve environment.

Approach:

1. By measuring the number of compliant public transport nodes in proximity to the specific location, site can be decided.
2. Map shall be provided that highlights all the existing and proposed (by govt.) modes of transport in the immediate surrounding (800m) of the building.
3. Also, the frequency of all modes of transport should be recorded and their schedule of operation should be taken into consideration

Compliance:

Document the following information:

1. Frequency of public transport at the nearest route
2. Timings of public transport
3. Distance of the commercial complex from the nearest transit station. Should not be more than 800 m from building-recommended
4. Pedestrian and bicycling time consumption in order to reach the nearest station. If Distance of transit station > 800m then specify this distance

GLOSSARY

Local Urban Centre: This is any community focal point, as these will be served by public transport networks. This includes local shops and/or community facilities such as doctor's surgery/dentist/library/school, a major transport node such as a railway/bus station/transport node, or another type of significant non-leisure related meeting place. [F]

Main building entrance: The main building entrance is the entrance to the assessed building accessed by the majority of the building's staff and visitors, not the site entrance (unless the site entrance is also the building entrance e.g. building with a boundary on a public highway). [F]

Major Transport Node: This is any node on a regional/national transport infrastructure system. [F]

LT2 : Promotion of non-motorised transit

Intent:

To encourage use of bicycles as well as pedestrianising short commute distances in order to promote improvisation in health.

Requirements:

Criteria	Points
The commercial complex design should be in such a way that an ample amount of space has been allocated for the parking of bicycles.	1
Design should include dedicated resting spaces for pedestrians.	1
Proposed bicycle paths should be integrating with those of the commercial building campus .	1

Behind the Intent:

While the cities are urbanising at a much faster rate, people are also getting used to unhealthy habits in order to maintain their schedule. For instance, even for the shortest distance of commute, they opt for a vehicle drive rather than walking. Hence, if activities like bicycling are enhanced and an interest. Ahmedabad is also becoming aware of the benefits of bicycling hence it has recently started bike renting program where bike stations are set up besides the BRTS bus stations. People can rent them for the day, and be back till evening, thus encouraging bicycling among them. This also helps maintain air quality.

Approach:

1. Develop a dedicated bicycle network that extends to the boundary of the property.
2. Provide short-term bicycle storage for at least 2.5% of all peak visitors, but no fewer than four storage spaces per building.[C]
3. Provide long-term bicycle storage for at least 5% of regular building occupants (excluding patients), but no fewer than four storage spaces per building in addition to the short-term bicycle storage spaces.[C]
4. Provide at least one on-site shower with changing facility for the first 100 regular building occupants (excluding patients) and one additional shower for every 150 regular building occupants thereafter. [C]

Compliance:

Required Documentation:[C]

1. Vicinity map showing bicycle network and route and distance along network to eligible destinations
2. Site plan showing bicycle storage locations
3. Site plan showing bicycle storage location with walking route to main entrance
4. Calculations for storage and shower facility
5. Description of programs to support bicycle use

GLOSSARY:

Functional entry: a building opening designed to be used by pedestrians and open during regular business hours. It does not include any door exclusively designated as an emergency exit, or a garage door not designed as a pedestrian entrance.

*Long-term bicycle storage :*Bicycle parking that is easily accessible to residents and employees and covered to protect bicycles from rain and snow

*Short-term bicycle storage :*Non-enclosed bicycle parking typically used by visitors for a period of two hours or less

LT3: Street design modification

Intent:

To ensure inclusion of pedestrian pathways, bicycle pathways as well as recreational spaces along the street.

Also, to make sure that the existing or modified street pattern plays a vital role in improving connectivity as well as in accommodating the commercial activities.

Requirements:

Criteria	Points
Minimum space requirement for ample recreational space should be met according to the GDCR (General Development Control Regulation).	1
Minimum widths of the pedestrian and bicycle paths with their proper segregation, without disturbing the vehicular movement on the main road.	1

Behind the intent:

The city is experiencing a lack of organized pathways and streets. It also needs to redesign the existing ones so as to segregate the pedestrianised pathways from the newly proposed bicycle pathways. Also, beautification of these public mobility spaces need to be enhanced. Improving their functional capabilities as well, these places can serve as an important social and cultural node for the people to experience in the midst of routine life. Hence, adding recreational factors to the street design can become one of the most important tangible design decision that directly connects with the people.

Approach:

1. Clear distribution of space for pedestrian and bicycle paths
2. Specify the type of recreational activity to be included with respect to respective location

3. The area in the vicinity of the commercial complex should be identified and worked upon to develop it into recreational space. The margin of the site can be included in it.

Compliance:

Required Documentation:

1. Floor space index allowed on site
2. Ratio of open to built up area
3. % of area allocated to recreational activity (Specify the type)
4. Commercial activities active on that site

REFERENCES:

[1]: Census 2011

[2]: http://icrier.org/pdf/gujarat_11%20oct.pdf

[3]: <http://gpcb.gov.in/aaqm-results-of-ahmedabad-city.htm>

[A]: LEED Ref Guide BD+C Location & Transportation- Obtained from Prof. Baird via Blackboard

[B] GRIHA-LD-V2015

http://www.grihaindia.org/index.php?option=com_content&view=article&id=7

[C]: LEED Ref Guide BD+C Sustainable Sites- Obtained from Prof. Baird via Blackboard

[D]: Oct 2013, WB Sustainable Development Network, Ballaney, S. et al; Policy Research Working Paper 6664

[E] [https://igbc.in/igbc/html_pdfs/abridged/IGBC%20Green%20Buildings%20New%20Buildings%20Rating%20System%20\(V%20ersion%203.0%20with%20Addendum%204\)%20August%202015.pdf](https://igbc.in/igbc/html_pdfs/abridged/IGBC%20Green%20Buildings%20New%20Buildings%20Rating%20System%20(V%20ersion%203.0%20with%20Addendum%204)%20August%202015.pdf)

[F] BREEAM 2009- SD 5066A: Issue 1.1; Code for a sustainable Built Environment

[G] AUDA GDCR

SUSTAINABLE SITES

CATEGORY 2: Sustainable Sites (11 POINTS)

OVERVIEW

The Sustainable sites category emphasizes on evaluating the site conditions, integrating them with the existing ecosystem and other available natural resources.

In the case of Ahmedabad, sustainability related to commercial complexes include site development according to the local regulations, mandatory open spaces, equally balanced hardscape and softscape, management of rainwater runoff.

As is evident from the city profile, Ahmedabad is pretty dense at the city core. Another unique characteristic about the city is that it had a lot of cotton and textile mills cropping up in the 19th century. Most of them have now been shut down, and the area is yet to be reclaimed[D]. These sites should be given priority for development, so that the urban core may be redeveloped. Redevelopment here would not mean only densifying the core, rather it would be about using vacant or the apparently vacant areas in the middle of the city.

The city also has a rich heritage history and background. Most of the sites thus fall under the protected category, on which new construction may not take place. In a place as culturally diverse as this, it is necessary to keep in mind the 'social' consequences of constructing and/ or refurbishing buildings near the waterfront and other heritage sites.

CREDITS:

SS	CREDIT	Description	Points
PR	Environmentally Assessed Site	Environmental Impact assessment reports mandatory	Pre req
SS1	Sustainable site planning	Eco sensitive and other zonal regulations	4
SS2	Land reuse	Utilization of vacant land in city	2
SS3	Ecological Impact	Management of ecological footprint of the project	3
SS4	Rainwater Management	Rainwater harvesting management	2

PREREQUISITE CREDIT : ENVIRONMENTALLY ASSESSED SITE

Intent:

To ensure, that the site does not possess any pollutant chemicals and is ecologically protected while the further development will not affect its existing biodiversity.

Requirements:

Criteria	Points
The site needs to be certified by the GPCB (Gujarat Pollution Control Board)	Pre req
Environmental impact report has to be prepared.	Pre req
If the site happens to be contaminated, then it should be remediated to meet the local requirements of the AUDA before implementing any project on it.	Pre req

Behind the Intent:

A site assessment is necessary because it leads to the design decisions at a later stage. It identifies the pros and cons of site beforehand. Knowing the actual microclimate, quality of soil, slope, solar condition, vegetation, topography, wind direction, availability of water and using them to make design decisions can impact the building's performance in long run. It can also help to reduce the costs. Existing features can be used in an optimistic way to maintain occupants' health and overall ambience of the place.

Approach:

1. Conducting an analysis of site and documenting the positive and negative features
2. Completing a site assessment worksheet

Compliance:

Document the existing data:

1. Topography : Contour mapping, unique topographic features, slope stability risks.[1]
2. Climate : Solar exposure, heat island effect potential, seasonal sun angles, prevailing winds, monthly precipitation and temperature ranges.[1]
3. Vegetation : Primary vegetation types, greenfield area, significant tree mapping, threatened or endangered species, unique habitat, invasive plant species.[1]
4. Soil : Type of soil
5. Human use : Views, adjacent transportation infrastructure, adjacent properties, construction materials with existing recycle or reuse potential.[1]

Prepare a Site assessment worksheet:

1. The worksheet or narrative must indicate which site features were evaluated, what was found, and how the findings influenced the project design.[1]
2. If certain features were not assessed, describe why they were excluded.[1]

GLOSSARY:

1. Greenfield area : Area that is not previously developed, graded or disturbed, and could support open space, habitat, or natural hydrology [1]
2. Site assessment : An evaluation of an area's above the ground and subsurface characteristics, including its structures, geology, and hydrology. Site assessments typically help determine whether contamination has occurred and the extent and concentration of any release of pollutants. Remediation decisions rely on information generated during site assessments. [1]

SS1: Sustainable Site Planning

Intent:

To implement sustainable planning strategies for developing the site in such a way that these protect the natural features on site that include natural drainage channels, vegetation cover, fertile soil and others.

Requirements:

Criteria	Points
Selection of site should ensure that the site is not located in an eco-sensitive zone like a forest or a flood zone etc [2]	1
The project site should comply with the provisions of 1. eco-sensitive zone regulations, 2. coastal zone regulations, 3. heritage areas (identified in the master plan or issued separately as specific guidelines), 4. water body zones (in such zones, no construction is permitted in the water- spread and buffer belt of 30 meter minimum around the FTL), 5. various hazard prone area regulations, and 6. others if the site falls under any such area.[2]	2
The vegetation cover on site may be increased by 25%. [2]	1

Behind the Intent:

If the natural topography is disturbed due to the new construction then it can have major consequences. On a given site, natural drainage channels should not be disturbed as far as possible so as to reduce the risk of flooding. Proper site planning can ensure better natural storm water management for the new development. Also, the existing vegetation cover should be

maintained in order to keep the upper layer of soil intact and thus avoiding erosion to a great extent.

Approach:

1. Judicious site planning should be carried out. Every site has several key natural features that must be retained during construction and incorporated in the final development plan. [2]
2. Regarding vegetation, in case some trees are falling in the building or service footprint and design cannot be altered, then those trees should be transplanted on the site itself. [2]
3. The site plan of the project must be developed in manner such that the key natural water bodies and surface drainage is preserved and any construction causing damage to them should be avoided.[2]

Compliance:

1. Document the existing features and include them in the planning and designing stage of the building as well as landscape design.
2. Submit the proposed site plan demarcating proposed building footprint , contours , landscape area , road network , footpaths , parking areas and other paved areas.[2]
3. Submit a storm water management calculation demonstrating that the post- development peak run-off rate and quantity of last 2 year-24 hour peak and 5-year 24 hour peak does not exceed the pre-development peak run-off rate and quantity.[2]
4. Submit a plan marking the existing native vegetation and the proposed no. of trees to be cut and to demarcate the places where they will be replanted.

GLOSSARY:

1. Native vegetation: An indigenous species that occurs in a particular region, ecosystem, and habitat without direct or indirect human actions.

SS2: Land Reuse

Intent:

To promote the use of previously developed land or brownfield sites by refurbishing its drawbacks rather than developing a new one. Hence, to encourage a positive change by making use of the previously contaminated land and treating it likewise.

Requirements:

Criteria	Points
At least 75% of the proposed development's footprint is on an area of land which has previously been developed for use by industrial,	2

commercial or domestic purposes in the last 50 years, and is now lying vacant. (If such site exists) [3]	
Where the site investigation, risk assessment and appraisal above has determined that the site was significantly contaminated, the client or contractor confirms that remediation of the site will be carried out in accordance with the recommended remediation strategy and its implementation plan as set out by the Contaminated Land Specialist and any relevant national or other legislation. [3]	

Behind the Intent:

It is always recommended to reuse the previously developed land due to ecological reasons as well as capital investment reasons. The developer does not need to invest the amount to develop the site infrastructure if it already exists to some extent. Also, if the site has been contaminated or is not being used due to some reasons, then redeveloping it would be an optimum utilization of the existing sources.

Approach:

1. To prioritise the selection of land which has been previously developed.
2. To get the contamination level of the land assessed (if contaminated) and reported in order to plan remediation strategies.

Compliance:

1. Submit the site photographs of its previous use or the previous existing plan[3]
2. Submit the proposed site plan with the new building footprint at design stage[3]
3. A copy of specialist's report on land contamination.[3]
4. Existing site plan showing remediation proposals for the contaminated site.[3]

GLOSSARY:

1. *Previously Developed Land*: It is defined as the one which is or was occupied by a permanent structure, including the curtilage of the developed land and any associated fixed surface infrastructure.
2. *Contaminated land* : is land that has been polluted with harmful substances to the point where it now poses a serious risk to human health and the environment. [1]
3. *Brownfield sites*: land or premises that have previously been used or developed. They may also be vacant, or derelict. However, brownfield sites can not be assumed to be contaminated as this will depend on previous use.[1]
4. *Remediation* : Activity undertaken to prevent, minimise, remedy or mitigate the risk caused by contaminated land to human health or the environment. [3]

SS3: Ecological Impact

Intent:

To maintain the existing ecology of the site by minimising the impact of the new construction on it. To conserve the vegetation and biodiversity of the site.

Requirements:

Criteria	Points
Ecological Footprint of site calculation based on the use and occupant density	1
Mitigation measures planning and implementation Construction activity management plan and its implementation	1
Environmental impact assessment in pre and post construction stage	1

Behind the Intent:

The existing flora and fauna of the site needs to be preserved from environmental point of view.

Preservation and conservation of intact or high-quality native ecosystems, including their soils, native vegetation, sensitive species habitat, wildlife corridors, and hydrology, contributes to maintaining overall ecosystem health. Projects should endeavor to situate buildings in ways that protect undeveloped land.[1]

Approach:

1. Calculate the ecological footprint of the proposed commercial complex on site.
2. Accordingly, set the range of acceptable parameters for changes on site that can directly or indirectly affect the ecology.
3. Mitigation measures must be planned out according to the recommendations given by the ecology expert.
4. Planning for proper management of site features to mitigate the long term consequences of this development.
5. Develop a construction activity management plan to avoid construction damage to the greenfield area.

Compliance:

1. Submit a report on the ecological assessment of site
2. Greenfield area calculations [1]
3. Soil test report
4. Existing wildlife survey report
5. Site plan depicting project boundary, building footprint, preserved greenfield area(s) (if applicable), previously developed area, restored area, native and adapted vegetation, plant species, other ecologically appropriate features, and any other relevant site conditions .[1]

GLOSSARY:

1. *Ecological Footprint* :The ecological footprint is a measure of human demand on the Earth's ecosystems, the amount of natural capital used each year. The footprint of a region can be contrasted with the natural resources it generates.^[4]
2. *Greenfield area* : Area that is not previously developed, graded or disturbed, and could support open space, habitat, or natural hydrology

SS4: Rain Water Management

Intent:

To reduce the surface runoff effectively by implementing various rain water harvesting strategies as well as using the natural topography of the site to improve groundwater recharge. Also, to address the flood risk of the site.

Requirements:

Criteria	Points
Percentile of the rainfall events and thus planning of the strategies for runoff prevention[1]	1
Rain water harvesting strategies implemented	1

Behind the Intent:

Conventional site development disrupts natural hydrological systems and watersheds through impervious surfaces, soil compaction, loss of vegetation, and loss of natural drainage patterns. The cumulative effect of these changes is disruption to the natural water balance and water flow. Typically, a conventional site's rainwater management technique is to address runoff by piping and conveying it as quickly as possible into centralized, large facilities at the base of drainage areas. However, such a strategy, although intended to prevent flooding and promote efficient drainage, can harm watersheds: it increases the volume, temperature, peak flow, and duration of runoff, eroding streams and causing other ecological damage .[1]

Approach:

1. Determine the surface runoff from the annual rainfall in the region
2. Hence, develop the rain water harvesting strategies and plan them in the initial stages of design.
3. Check whether there is a flood risk to the site, and take measures accordingly.

Compliance:

1. Submit the proposed water balance table and calculations, along with supporting documents/drawings, for the entire development highlighting total rainwater being reused and recharged[2]
2. Submit the site plan/plumbing layout along with narrative highlighting:
Rainwater harvesting system and recharge wells – along with filtration system details[2]
3. Site plans/sections confirming :[3]
 - The design flood level for the site.
 - The design ground level(s) for all developed areas of the site.

REFERENCES:

- 1.LEED-Sustainable Sites (BD+C)
- 2.GRIHA_LD_2015,TERI
3. BREEAM 2009- SD 5066A: Issue 1.1; Code for a sustainable Built Environment
- 4.https://en.wikipedia.org/wiki/Ecological_footprint

WATER EFFICIENCY

CATEGORY 3: Water Efficiency (7 POINTS)

IDENTIFICATION OF ISSUES:

1. Irregular maintenance of the existing water supply and disposal system
2. Proper cleanliness of the natural water resources
3. Regulation of water auditing
4. Recommendation of fixtures/appliances for the new construction
5. Alternative water resources identification and implementation
6. Heavy water clogging during peak monsoons

OVERVIEW

The WATER EFFICIENCY Category addresses the issues related to making a building water efficient and its immediate direct and indirect impacts on surroundings. With an overall (country) population of around 1.2 billion, it is estimated that 103.8 million people do not have access to safe water, and 802 million no access to sanitation services¹. While Ahmedabad can meet its water demands by sourcing water from the River Narmada, it is a good practice to use water efficiently, so that other parts of the state or even country can benefit.

Source of water	2011 (In MLD)
Raska	200
Narmada Canal	330
Intake well 1&2	495
Dudheshwar water works	70
Jaspur water treatment plant	275
Frenchwell (7 No.)	200
Bore wells (532 No.)	280
Total	1850

Source: (AMC, 2012)

The chart on the left gives us exact figures in terms of how much water we get from the various sources available to us. The majority of the water is supplied via intake well in the city, and from the Narmada Canal.

Figure 11: water source and capacity, adopted from CSP Ahmedabad

Existing water quality data:

Water Treatment Plant	Capacity (In MLD)	Actually treated (In MLD)
Kotarpur WTP	715	550
French Wells	75	75
Dudheshwar WTP	70	25
Jaspur WTP	275	190
Raska WTP	200	110
TOTAL	1620	950

Source: (AMC, 2012)

Figure 12: water treatment plant capacity, adopted from CSP Ahmedabad

We also examined data from the Ahmedabad Municipal Corporation for how much water is being treated presently. A report on the water supply profile of the city, prepared by the municipal corporation in 2011 projects the water demand to cross 1620 MLD by the year 2030. Comparing that with the capacity of the sources of water supply, we are at present in the clear. About 80% of the water is being treated (if we assume that water is being supplied to the city by the Narmada Canal, the intake wells, bore wells and the Dudheshwar water works).

S. No.	Performance Indicator	Benchmark *	2010-11	2011-12 (till Dec)
1	Coverage of water supply connections	100%	90%	92%
2	Per capita supply of water	135 lpcd	140 lpcd	147 lpcd
3	Extent of metering of water connection	100%	0 %	NA
4	Extent of Non Revenue Water (NRW)	20%	26%	20%
5	Continuity of water supply	24*7	2.25 Hrs Daily	2.25 Hrs Daily
6	Quality of water supplied	100%	99%	99.5%
7	Efficiency in redressal of customer complaints	80%	99%	99%
8	Cost recovery in water supply services	100%	78%	82%
9	Efficiency in collection of water supply related charges	90%	81%	82%

Source: (AMC, 2012); Comparison done by UMC.

Figure 13: performance indicator benchmarks

CREDITS:

Ahmedabad is not facing acute water shortage as yet, due to the presence of the river and canals. But comparing the 2011-12 values of performance indicators against the benchmarks set make it very clear that the city still has a long way to go. It for for this reason that the following credits have been suggested:

W	CREDIT	Description	Points
PR	Documentation of existing water supply and disposal	Pre-req to qualify for this category	PRE REQ
W1	Maintenance of Water systems	Water efficient systems Augmentation of natural water resources	2
W2	Water Audit	Central monitoring systems Reduction in water use	2
W3	Alternative Water Resources	Sustainable and/ or alternative sources for water consumption	2
W4	Prevention of water clogging	Provision of sensors and drain lines	1

W PREREQUISITE: DOCUMENTATION OF EXISTING WATER SUPPLY AND DISPOSAL

Intent:

To ensure that the existing building or the new construction is using the permissible amount of water (as per the GDCR)

Requirements:

Criteria	Points
Document the usage statistics for water	Pre req

Behind the Intent:

To achieve the goal of providing 24 by 7 water supply to the city (as per AMC 2012 performance indicators), the first step would be to document the existing statistics for water supply and drainage/ sewage systems. The numbers thus obtained would help in giving directions to the designers on where they can save water, and reuse it.

Approach:

1. Building owner to ensure that rate of water supply, and of other drainage systems are recorded
2. Water supply timings and hours to be recorded

3. Proximity of building to a water and sewage treatment plant to be documented.

Compliance:

1. Complete and document the following information:
 - a. Existing water resources present in locality:
 - b. Drainage systems:
 - c. Water supply station :
 - d. Water supply hours :
 - e. Water disposal rate (per day):
 - f. Proximity to treatment plants for water and sewage:
 - g. Steps to reduce water wastage :

W1: Maintenance of water systems

Intent:

To maintain the water supply and disposal systems in order to ensure health and hygiene of subjects.

Requirements:

Criteria	Points
Water efficient systems	1
Augmentation of natural water resources	1

Behind the Intent:

While Ahmedabad enjoys easy water accessibility, nearby villages suffer from water shortage [7]. Most of the fresh water available is getting polluted, and its total available amount is also decreasing due to climate change and “salination” of fresh water bodies. [10] This credit aims to create awareness about the finite-ness of water, and promote water efficient measures by using efficient fixtures and at the same time, supplement the existing water resources we have. [9]

Approach:

1. To determine the water consumption figure for the assessed building, determine the effective flush volumes and flow rates for the following installed sanitary fittings [6]
 - a. WCs
 - b. Urinals
 - c. Taps
 - d. Showers
2. Exclude kitchen taps, cleaners’ sinks and external taps.

3. If any rainwater collection or greywater recycling systems are specified for the purpose of meeting WC/urinal flushing demand, determine the following information (as appropriate to system type):
 - a. Annual rainfall for the site location (mm)
 - b. Rainwater catchment area (m²)
 - c. Catchment type e.g. pitched roof, flat roof
 - d. Rainwater collection tank capacity
 - e. Percentage of tap and shower water collected and used for WC/urinal flushing
 - f. Percentage of building's WC/urinals using greywater to meet flushing demand. [6]

Compliance:

1. Use of leak resistant fixtures that reduce 25-30 % of water wastage in and around the building [6]
2. Having a low pressure water system (60-80 psi) inside the building [NBC 2005]
3. Provision of storm water drains in construction areas
4. Utilizing rainwater for non potable water purposes, as much as possible
5. Provision of water/ sewage treatment facility in construction areas having built up of more than 2000 sq mts. [6]
6. Provision storm water drains to prevent water clogging in low lying areas
7. Provisions for harvesting rain water: about 30% of the total site area should be utilized (surface and roof runoff) [6]
8. Provide groundwater rechargers for construction sites having more than 2000 sq mts built up
9. Percolation wells should be provided in large construction sites (Site area above 200 sq mts)
10. Proper segregation of indoor and outdoor used water and directing the water to be reused in a system on site to be able to utilize it again for other purposes.
11. A copy of the relevant section of the M&E specification and/or manufacturer's details confirming:
 - a. Technical specification of sanitary fittings and controls to be installed
 - b. Location, size and details of any rainwater and greywater collection system
 - c. Design plan showing the location within the building of the sanitary and grey/rainwater collection facilities [6]

W2: Water audit criteria

Intent:

Monthly auditing of water is needed to keep a check on over usage and also to ensure implementation of proper water efficient strategies.

Requirements:

Criteria	Points
Central monitoring systems	1
Reduction in water use	1

Behind the Intent:

Metering the water systems allows the user and owner to be in control of how much water is being used, and also wasted. A central water monitoring system would also help in tracking any leaks or pressure differentials that may happen in the water mains. This would in turn increase the efficiency of water management systems to be installed, and also maintain the structural integrity of the building, which could be compromised if water starts leaking. [9]

Approach:

1. The specification of a water meter on the mains water supply to each building; this includes instances where water is supplied via a borehole or other private source. [8]
2. The water meter has a pulsed output to enable connection to a Building Management System (BMS) for the monitoring of water consumption. [9]
3. Utilizing low flow fixtures in accordance to National Building Code, Bureau of Indian Standards–2005, Part IX–Plumbing Services, Section 1–Water Supply, Drainage and Sanitation (including Solid Waste Management) [6]

Compliance:

1. A copy of the specification clause confirming the specification and type of water meter(s). [6]
2. Design plan(s) showing location of the water meter(s) in each assessed building/unit. [6]
3. Schedule of water efficient fixtures and fittings that reduce the per capita water use by 30-35 % than the conventional standards.
 - a. Water flow fixtures are recommended to have flow rates of less than 7.5 lpm.
 - b. Flushing devices are recommended to be using 3-4 litres per flush. [11]
4. Monitoring use of water treatment plants [6]
5. Monitoring presence of leakages, and their repair [6]

W3: Alternative Water Resources

Intent:

To address the need of judiciously using water by implementing different strategies.

Requirements:

Criteria	Points
Recycled/ reused water contributes to 10-15% of total building water use [9]	1
Additional point for contribution of harvested rain water (upto 20% of total building use)	1

Behind the Intent:

Use of greywater discharged from lavatories, showers and wash basins, after its treatment should be promoted. This would help in reducing the overall water consumption load of the building on the city supply. It would also reduce the treatment load on the city water treatment plants as well, to a certain extent.

Another way to reduce the water consumption load on the main supply line would be to incorporate rainwater harvesting in the project, and use the water captured thus to meet a part of the total water load of the building. Rain water may be collected from the roof, and also from the open areas on the ground, and stored in an underground water tank. Such water can be utilised for non potable purposes. [9]

Approach:

1. Include recycling systems during the course of planning and construction
2. Employ water efficient cooling systems
3. Reusing graywater for nonpotable water usages, with necessary treatment
4. Use of semi pervious materials wherever necessary for ground water recharging
5. Employing Rain Water Harvesting techniques and recording the total water savings annually which should save around 30% of the water used. [6]

Compliance:

1. Detailed Project Report describing and detailing the proposed strategy of gray/black water recycling/reuse and/or rainwater harvesting system including collection, distribution and storage.
2. Hydraulic plans and schematics of the proposed gray and black water system and/or rainwater harvesting system, including collection distribution and storage

W4: Prevention of water clogging with appropriate design solutions

Intent:

To address the issue of water clogging faced in certain areas of the city during the monsoon season. This credit should especially address the basements.

Requirements:

Criteria	Points
Prevent water clogging inside buildings	1

Behind the Intent:

Ahmedabad is increasingly facing the problem of water logging in the city. Water starts entering the building, flooding the basements. To remove this water from buildings, it is beneficial if the developers take action without waiting for the city authorities to act.

Approach:

1. Design should incorporate proper drainage solutions to the basement, so that the probability of water accumulation is lessened to a great extent.
2. Provision of adequate sewage pumps/drainage pumps to get rid of rainwater as soon as it starts getting accumulated.
3. Provision of water sensors to indicate clogging, which ensures that the area affected is evacuated in very less time.

Compliance:

1. Provide drawings for storm water drainage on site
2. Clearly mark pumps, manhole lids and lines

REFERENCES:

Weblinks:

[1]<http://www.teriin.org/events/iwf/files/presentations/Day2/Session3/Dr-Suresh-Kumar-Rohilla.pdf>

[2]water.org/country/india; accessed on 9/28/2015

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[4]http://www.egovamc.com/building_plan/building_pdf/gdcr_final.pdf

[5]http://www.academia.edu/10857700/City_Sanitation_Plan_Ahmedabad_Urban_Management_Centre; accessed on 9/28/2015

Rating systems:

[6] BREEAM 2009- SD 5066A: Issue 1.1; Code for a sustainable Built Environment

[7] Census 2011

[8] GRIHA V 2015; TERI

[9] LOTUS 2015; Vietnam Green Building Council, LOTUS Non Residential Rating Tool V2.0

[10] Ministry of water resources, CSP - Ahmedabad, 2013

[11] National Building Code; Bureau of Indian Standards 2005

ENERGY AND ATMOSPHERE

CATEGORY 4: Energy and Atmosphere (10 POINTS)

IDENTIFICATION OF ISSUES:

1. Excess use of fossil fuels as energy source
2. Lack of awareness for proper utilization of solar energy that is available abundantly
3. Lack of proper specification of standards that should be maintained while installation of different kinds of fixtures that contribute to major energy consumption.
4. Lack of awareness on the harmful effects of CFC's on the ozone layer.

OVERVIEW

This category caters to reduction of energy wastage and extended use of the modern technologies that are capable of making buildings energy efficient. At present 54.09% or 93918.38 MW (Data Source CEA, as on 31/03/2011) of total electricity production in India is from Coal Based Thermal Power Station. Ahmedabad gets its electric supply from a private company called Torrent Power. It has 4 power plants, two in Ahmedabad, one in Surat and one in Jamnagar. It has a steady supply of electricity, with no fluctuations perceived. Torrent Power has an aggregate generating capacity of about 1697.1 MW of power.

1. 49.6 MW wind plant at Jamnagar
2. 1147.5 MW SUGEN gas based mega combined cycle power plant near Surat
3. 400 MW coal based thermal power station at Sabarmati, Ahmedabad
4. 100 MW gas based combined cycle power plant at Vatva, Ahmedabad.

(The above information has been obtained from the company's website)

Gujarat does not have any coal reserves of its own. It gets the resources from neighboring states. The coal ministry of India estimates a total of 301 billion coal reserves, but it is a fossil fuel, and should be discouraged.

Energy consumption is measured at the building site, and may be submetered if it is a residential apartment/ commercial complex. Sub metering to the extent of identifying how much power is being utilized by a particular system does not happen.

Commonly used equipments :

Ceiling fans are used on a large scale

Generally heating is not required

For natural ventilation, windows are the main source.

For mechanical ventilation, air conditioners are used

Distribution Network Details	
Highest System Voltage	220 KV
No. of EHV Substations	13
No of 33 KV Substations	3
Power Transformer Capacity (in MVA)	1414
Distribution Transformer Capacity (in MVA)	1460

Figure 14: Distribution Network

CREDITS:

EA	CREDIT	Description	Points
PR1	Commissioning energy efficient methods and implementing passive design	Use of passive architecture to reduce cooling and heating loads	Pre req
EA1	Renewable Energy Use	Promoting renewable sources of energy	2
EA2	Energy Metering and Documentation	Improve energy benchmark	3
EA3	Energy Performance evaluation	Determine high performance simulation model	3
EA4	Discontinuing use of refrigerants	To discourage use of CFC's in refrigerants.	2

PREREQUISITE CREDIT 1: Commissioning Energy Efficient methods and implementing passive design strategies

Intent:

To recognize the natural resources that can be used in order to minimize the cooling and heating loads on the mechanical systems. To use passive design strategies in order to take maximum advantage of existing climatic conditions by designing accordingly.

Requirements:

Criteria	Points
Using either of the below mentioned strategies: Commercial buildings should have PV on the site in order to generate at least 15-20% of their required electricity demand[5] OR Use of passive architectural design methods in planning stage such that total costs are reduced than the initial anticipated costs.	Pre req
Proper ventilation and lighting to reduce the load on mechanical systems by 15% (recommended) from the initial load.	Pre req

The Lighting Power Density in the building interior, exterior and parking areas shall be reduced by minimum 10% over ECBC base case.[2]	Pre req
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Behind the Intent:

In order to make the most use of existing conditions, some design strategies have to be implemented. For instance, the appropriate orientation of the building can reduce the use of artificial ventilation by allowing the natural air flow from specific direction. Similarly, use of equipments that are operated by renewable energy make the building more energy efficient by cutting down the energy costs. Hence, by implementation of site specific strategies, a sustainable energy efficient structure can be achieved.

The commissioning process is an integrated set of activities intended to ensure that the project meets both the design intent and the owner's operational needs.

Approach

1. Conduct a passive design analysis [8].
2. Application of either of the above mentioned methods (in requirements).

Compliance

1. To ensure that the electric equipments used are in compliance with the BEE star rating system.
2. Documentation of annual measurements and thereby recording the annual energy savings in order to rate the performance of energy efficient equipments.
3. Submit specification sheets and purchase orders to demonstrate that all fans being installed in the project at BEE star rating.

EA1: Renewable Energy Use

Intent:

To discourage the use of non renewable energy sources by applying strategies that maximize the use of renewable energy sources, thus ensuring environmental harm reduction.

Requirements:

Criteria	Points
Use of solar powered devices	1
On-site/Off-site renewable energy system installation to offset a part of the annual energy consumption of internal artificial lighting and HVAC systems	1

Behind the Intent:

Renewable energy use ensures reduction in total cost of the energy demand as it can be generated on site as well as offers benefit by reducing the pollution. It can reduce carbon emissions to a great extent. Use of renewable energies from sun, wind etc. is inevitable. [5]

Approach:

1. Annual electricity saving of 166 kWh for residential and commercial consumers recommended. [5]
2. Set a renewable energy target [5]
3. Calculate and compare the renewable energy cost contribution with the conventional energy cost contribution. [5]
- 4.

Compliance:

1. Submit design calculations for renewable energy system sizing and on-site annual energy generation potential. [6]
2. Submit drawings in CAD format to show location of renewable energy systems [6]
3. Submit documents supporting off-site generation of energy through renewable energy systems. These may be either: Renewable Energy Certificates (RECs) for at least 2 years along with a declaration that the RECs are not being used for any other obligatory requirements and will be purchased every year OR Power Purchase Agreement from the utility for purchase of green power. In the agreement, the address of the particular site must be mentioned [6]
4. Use renewable energy systems to offset building energy costs. Calculate the percentage of renewable energy with the following equation:
 - $\% \text{ renewable energy} = \frac{\text{Equivalent cost of usable energy produced by the renewable energy system}}{\text{Total building annual energy cost}}$ [5]

EA2: Energy Metering and documentation

Intent:

To help in improving energy benchmarking by gathering relevant data, and formulate a rebate program.

Requirements:

Criteria	Points
Ensuring the correct installation of energy meters, to avoid pilferage of electricity	1

Documentation of electrical data at a regular interval of 15-20 minutes.(if permitted by users)	1
Creating an energy use pattern trend to estimate energy use and potential energy saving measures	1

Behind the Intent:

Whole-building metering lets building operators track energy consumption over time, illustrating variations in usage patterns that can be used to develop energy conservation measures over the lifetime of the building. Once such conservation measures are in place, metering then allows staff to track energy savings and used to justify additional investments with calculable payback periods. Building operators gain detailed feedback, enabling them to precisely calibrate operational parameters, depending on the needs of changing occupancy groups, while continuing to operate building systems efficiently. [5]

Approach:

1. Identification of all the energy sources of the building[5]
2. Determine number,type and location of meters[5]

Compliance:

1. Submit a site plan with details of Building areas,Occupancy,Location of meters in respective spaces
2. Specify the type of meter needed.
3. Encourage usage of sub metering

EA3: Energy Performance Evaluation

Intent:

To calculate the prospective energy efficiency of the building by simulating its model to know its performance beforehand which can in turn reduce the environmental impacts by proper design decisions.

Requirements:

Criteria	Points
Determination of a high performance model that is closest to the optimized baseline model , ensuring improved energy efficiency	2
Appropriate HVAC modelling	1

Behind the Intent:

A building can be optimized for its energy use by running simulations. This performance path gives the flexibility to experiment on various combinations of material assemblies and achieve required energy efficient structure. This can help in reducing the operation and maintenance costs. Also, it provides the data from which thermal comfort, indoor environmental quality and lighting strategies can be decided during the design phase. Early intervention in these issues leads to a smooth post-design process.

Approach:

1. Collect the weather data of Ahmedabad's sub region where the site is located.
2. Appoint a qualified Energy Modeller.
3. Decide the material assemblies and calculated estimations for various factors such as number of occupants, equipments etc.
4. Also, decide the HVAC system options
5. Run simulations by changing different parameters
6. Decide on the best case model that offers maximum optimization of energy consumption and implement in designing further.

Compliance:

1. Document the results of all parametric simulations and present the best case model
2. Specify whether prescriptive path was followed or the performance path.
3. Document the occupant, light density and equipment density schedules.
4. Also operational schedules should be reported in order to get the factual results.
5. Cooling Demand density/total heat gain through building envelope* should meet the ASHRAE/GRIHA thresholds [6]

GLOSSARY:

1. *Building energy simulation*: Also called building energy modeling (or energy modeling in context), is the use of software to predict the energy use of a building.

EA4: (Discontinuing) use of refrigerants

Intent:

To ensure our part in protecting the ozone layer, and preventing its depletion. This may be done by using more ecological friendly options.

Requirements:

Criteria	Points
Identify all new HVAC&R equipment in the project that contains refrigerant and confirm that CFC refrigerants are not used.[5]	2

The fire suppression systems and fire extinguishers installed in the building are free of halon.[6]	1
All the insulation used in building should be CFCs and HCFCs free .[6]	1

Behind the Intent:

Ozone layer is one of the vital layer around earth that protects us against the harmful ultraviolet rays from the sun. The chlorofluorocarbons contribute in ozone depletion which is not at all desired for maintaining appropriate climate. Ozone depletion indirectly affects the biological ecosystem, as well as causes diseases like skin cancer. Hence, new projects are restricted to use CFC based refrigerant based equipments.

Approach:

1. Selecting equipment that has low ozone depletion potential (ODP) and global warming potential (GWP), as well as no CFCs, will help achieve the related credit. [5]
2. Alternatives to CFC and HCFC refrigerants, such as HFC-410A, have lower refrigerant impacts but may require higher levels of energy use. Some energy-efficient systems, like variable refrigerant flow (VRF), may increase the overall refrigerant impact because of the relatively higher amount of refrigerants their operation requires.[5]

Compliance:

CFC Specification of the used product as mentioned on label : (Eg. HCFC-22, R12)

Type of equipment

Whether the equipment is exempt*

Insulation specification

Guarantee remark of the halon free fire extinguishing system

(*Equipment containing less than 225 g of refrigerant is exempted.[5])

GLOSSARY:

Chlorofluorocarbon (CFC)-based refrigerant: A fluid, containing hydrocarbons, that absorbs heat from a reservoir at low temperatures and rejects heat at higher temperatures. When emitted into the atmosphere, CFCs cause depletion of the stratospheric ozone layer.

REFERENCES:

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[https://igbc.in/igbc/html_pdfs/abridged/IGBC%20Green%20Buildings%20New%20Buildings%20Rating%20System%20\(V%203.0%20with%20Addendum%204\)%20August%202015.pdf](https://igbc.in/igbc/html_pdfs/abridged/IGBC%20Green%20Buildings%20New%20Buildings%20Rating%20System%20(V%203.0%20with%20Addendum%204)%20August%202015.pdf)
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http://igsd.org/documents/ReducingStressonIndiasEnergyGrid_Final23.pdf
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MATERIAL AND RESOURCES

CATEGORY 5: Material and Resources (12 POINTS)

IDENTIFICATION OF ISSUES:

1. Unplanned use of materials, extra load on material sources.
2. No or negligible construction, demolition waste management
3. Insufficient policies on reuse/ recycling of materials
4. No life cycle assessment
5. Material specifications and their effect on environment not specified

OVERVIEW

Ahmedabad had more than 1.1 million people by 1961, and another 1.5 billion by 2011 [3]. According to the census 2011 figures, compound annual growth rate of AMC calculates to be 4.7 from 2001-11, and 3.5 for AUDA for the same time frame. Construction industry is booming more in this decade, on the newer part of the city. Ahmedabad is a mix of two cities, the old and the new. There are commercial buildings which are around 20 years old, and there are also commercial buildings which are as recent as 3-5 years. Renovation is not a very popular strategy, although it is certainly viable for the place. Most new construction happens on undeveloped land, usually found at the outskirts of the city, which further increases the city limits. Such construction uses materials such as brick, concrete, steel and glass.

Plastic, solid waste and bio medical waste are segregated and recycled. Most of the construction waste was dumped in landfills, prior to 2013, now it is diverted to a plant that processes 300 tonnes of it on a daily basis [10]. Till some time ago, a lot of the by product waste of many factory processes was also being diverted to landfills. The Bureau of Indian Standards (BIS) is now encouraging the use of these by products of industries (case in point flyash, which is a waste by product of the coal fired power plants) in its Indian Standard (IS) codes for manufacture of bricks and cement.

Other kinds of materials that can be successfully incorporated in the building industry can be broadly classified into categories, namely: excavation soil, roadwork wastes, demolition wastes and complex wastes. Of these four, in the case of India, soil waste from foundation excavations is the most important, as the sand mafia is eroding the Aravalli belt range to excavate soil, gravel and pebbles, to then transport across state lines to all parts of the country. This is adversely affected the ecology of the region. Roadwork wastes can generally be used for roadworks and basic PWD works. The difference between demolition and complex wastes is that while the former deals with waste generated when “disassembling” the outer structure of a building, the latter deals with waste accumulated from disassembling the interiors. A detailed flowchart of the 4 kinds of waste, how they are obtained (resources), and what they constitute (components).

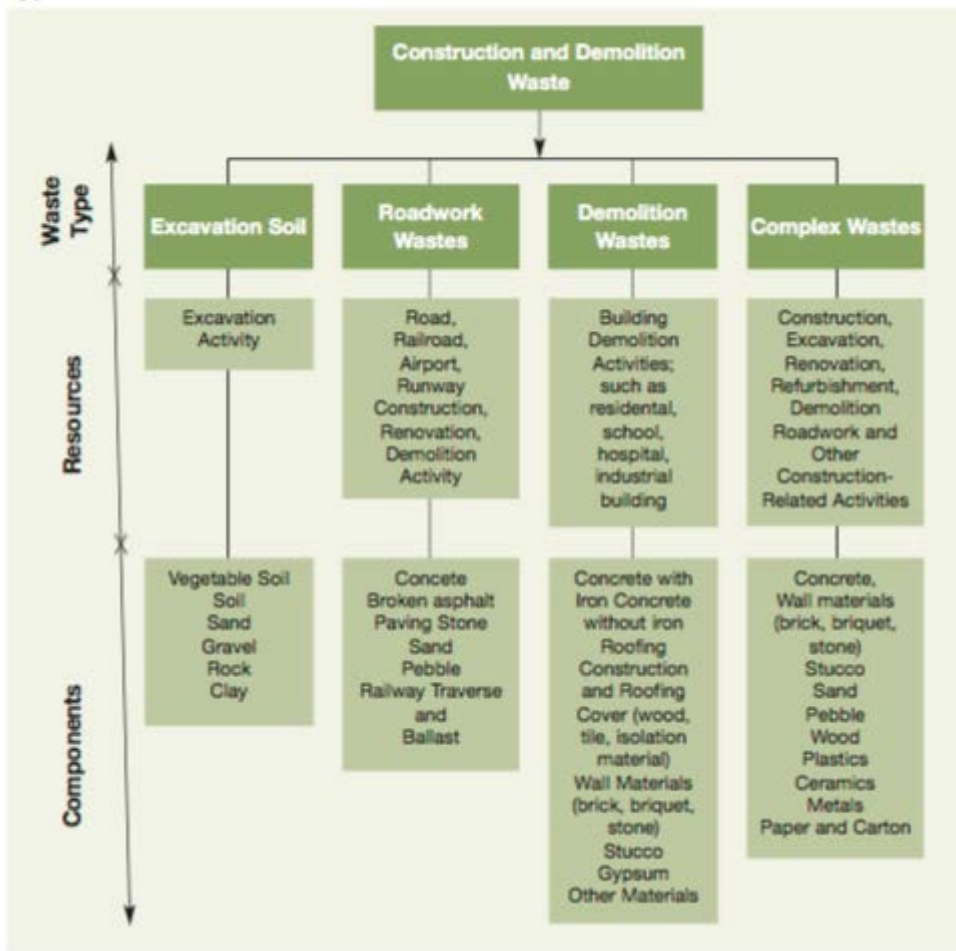


Figure 15: Types of construction and demolition waste in India [1]

There is no systematic approach to construction and demolition waste management, according to the Union Ministry of Forests and Environment (MoEF). Center for Science and Environment states that India has about 1 billion sqm of newly constructed floor space for the year 2013. Technology Information, Forecasting and Assessment Council's (TIFAC) assumes that anywhere between 40-60 kgs per sqm of construction waste is generated for new constructions. This number increases to 300-500 kgs per sqm for demolition and renovation repairs. Taking an average of this range gives us a figure of 50 MT of waste for 2013. Most of this waste becomes a part of lakes and ponds, so that they get filled up, and more land becomes available for developers to develop. It is therefore high time, that the Indian construction industry started using recycled materials.

Ahmedabad, in particular, has started taking some steps in this direction, by commissioning a 300 tonne construction and demolition waste processing plant, from the October of 2013. The waste collected here is being used to make materials such as bricks and tiles [10]. This does have one downside when compared to reusing the existing demolition waste, though. This is because when recycling materials, we add onto the environmental burden, in the form of carbon emissions and greenhouse gases. Materials which can not be reused can then be recycled, to converted to

energy. And this is where the life cycle assessment of materials comes into play. The lower the cost, the better the material.

CREDITS:

The various processes involved in getting a building material to the site (from its extraction and post extraction work, to transportation and use on the site to ultimately its disposal) can have adverse effects on our surroundings. Ministry of Environment and Forest is raising awareness of how our tree cover is just 21.23%, instead of the mandated 33% [5]. The report states that this increase has happened once the building industry started promoting the use of engineered and recycled wood as products. Also, when extracting material from the nature, like stones from the earth, the natural ecology of the quarry site gets imbalanced, with increasing air and water pollution [9]. To conserve and protect our environment, this credit will focus on encouraging recycled or reused sustainable materials, which are low in embodied energy [8].

MR	CREDIT	Description	Points
MR1	Materials made with recycled factory by products	Using flyash in major building materials as component.	5
MR2	Construction and Demolition waste management	Promoting recycling/ salvaging of building materials	2
MR3	Life cycle cost impact reduction	Promoting use of LCA to help choose materials	5

MR1 : Materials made with recycled factory by products

Intent:

Promoting use of BIS recommended wastes (such as fly ash, blast furnace slag etc.), which have characteristics similar to conventional construction materials. Since these products are considered as waste for their respective factory processes, their use in building construction industry would reduce the burden on landfills. [8] Since the Indian construction industry supports brick and reinforced concrete work, emphasis will be on these two materials.

Requirements:

Criteria	Points
Substitution of Ordinary Portland cement by flyash, in structural concrete by 15% [8]	1
Additional substitution of Ordinary Portland cement by flyash, in structural concrete by more than 25% [8]	2
Use of flyash in sundried/ kiln fired bricks - upto 40% of total composition [8]	2
Use of on/ off site waste like brick debris, concrete etc. in hardscaping [8]	1

Behind the intent:

Using recycled materials in products reduce waste. It also helps in reducing the “environmental impacts associated with extraction and processing of virgin resources”. Fly ash can be used in manufacturing Portland cement, as well as bricks. Quality of flyash for use in cement should be in accordance with the levels in Indian Standard (IS) code 1489:1991, Parts 1 and 2, to guarantee its structural integrity. For using silica fume as an alternate material, the quality should be as mentioned in IS code 15388:2003. The manufacture of Portland clinker accounts for approximately 90% of the greenhouse gas emissions associated with concrete production. [9]

Approach:

1. Reinforced concrete (RC) (including ready mix concrete) to make use of:
 - fly ash by using PPC containing fly ash. (Minimum 30% replacement of cement with fly ash in PPC (Portland Pozzolona Cement) by weight of the cement used in the overall RC for meeting the equivalent strength requirements). [8]
2. Use of fly ash- based bricks/blocks (for e.g., Fal-G stabilized, fly ash–sand lime bricks, load bearing and non-load bearing fly ash- based concrete blocks, fly ash - based light weight aerated concrete walling blocks etc.) in case of both load- bearing and non-load bearing wall systems, which utilize a minimum 40% of fly ash by weight of cement for 100% load bearing and non-load bearing walls. [8]

Compliance:

1. Fly ash use in RC : Minimum 30% replacement of cement with fly ash by weight of cement used in the total structural concrete. Provide supporting document from the manufacturer of the cement specifying the fly ash content in PPC used in reinforced concrete.
2. For use of fly ash in building blocks of load bearing and non-load bearing wall : Minimum 40% replacement of cement with fly ash by weight, for 100% load bearing and non-load

bearing walls Provide supporting document from the manufacturer of the pre-cast building blocks specifying the fly ash content of the blocks used in an infill wall system.

3. Provide supporting document from the manufacturer of the cement/ready mix concrete
4. Certificate from the architect specifying overall replacement of cement in the RC, pre-cast building blocks

MR2 : Construction and Demolition waste management

Intent:

Encourage best practices in the management of waste, including sorting, recycling and disposal of construction as well as demolition waste (where existing structure needs to be razed to build new structure). [6]

Requirements:

Criteria	Points
30% of construction/ demolition waste is recycled. [6]	1
60% of construction/ demolition waste is recycled. [6]	2

Behind the intent:

Construction and demolition waste includes waste from activities like construction, renovation, demolition, land excavation and road works. Ideally, waste is separated and inert material is used as fill in reclamation sites, when available. Land is at a premium, due to rapid urbanisation, with developers wanting to reclaim landfill sites. Unless solutions are identified immediately, we could face a crisis in the next decade of having nowhere to put the thousands of tonnes of waste thrown away every day. [6]

The city does not have any guidelines to collect and store building material recyclables at this point. This credit would help in developing a waste recycling management plan, on the level of the developer. This would include documentation and implementation of strategies they might undertake, that reduces the need for landfills for waste disposal and discourages use of incinerators as much as possible.

Approach:

1. Develop a Construction and Demolition Waste Management Plan (CDWMP) prior to the start of construction and demolition activities. [11]
2. Identify the materials to be diverted from landfill. If materials are planned for salvage, the plan must indicate their planned use. [11]
3. Target achieving a minimum final recycling/salvage rate of 30% of construction and demolition waste (by weight or volume). This figure excludes all hazardous waste that must undergo specialized treatment. [11]

Compliance:

1. Documentation and photographic evidence in form of a report by qualified person quantifying the amount of demolition waste recycled as a percentage of total demolition waste. The disposal of inert waste to public fill will not be considered as an acceptable strategy for fulfilling this requirement. [6]
2. The developer's representative on site shall be responsible for monitoring and reporting on the execution of the instructions and shall confirm through monthly reports the extent to which recycling and sorting has been achieved. [6]
3. The developer has to demonstrate that all waste and disposal are conducted in an environmentally friendly manner. [6]

MR3 : Life cycle cost impact reduction

Intent:

To address the use of sustainable material and products during the design stages or demonstrating a reduction in materials use through life-cycle assessment. [10]

Requirements:

Criteria	Points
Renovation of abandoned structure [10]	3
Life cycle assessment of entire building [10]	2

Behind the intent:

Restoration of existing buildings result in a reduction in energy use and waste associated with demolition and construction. A report by the National Trust for Historic Preservation, titled The Greenest Building: Quantifying the Environmental Value of Building Reuse, as quoted in the LEED Materials and Resources BD+C, “found that building reuse almost always offers environmental savings over demolition and new construction.” Restoring existing buildings preserves the local area’s characteristics and identity, and at the same time, to do not contribute as much to climate change effects, as a new construction would. [10] A cradle to cradle approach to be propagated. This should also be for materials used in such projects. Specifications of particular materials are needed in order to avoid the consequences of that material in later stages of building’s life cycle. Proper processes should be identified for different actions like from obtaining the raw materials to its transportation and use.

Approach:

1. Identify and quantify the surface areas of the structure and building enclosure that can and cannot be retained. Areas of the structure and building enclosure that are structurally unsound and must be demolished, as determined by a structural engineer. [10]

2. Proposed building must demonstrate at least a 10% reduction in global warming potential and a 10% reduction of two of four other impact measures (mentioned below) when compared to a baseline building, without increasing any measure by more than 5%. [10]

Compliance:

1. Calculate the percentage of the total surface area that will be reused
2. Ensure that the reusable areas are clearly defined and incorporated into the design and construction of the project.
3. Select appropriate tools and data sets for LCA calculations
4. Create and model baseline building
(LCA impact indicators - Global Warming Potential, Ozone depletion Potential, Acidification/ Eutrophication Potential, Depletion of non renewable energy resources)
5. Use LCA to make design decisions that reduce environmental impacts [10]

REFERENCES:

Weblinks:

[1]<http://www.cseindia.org/userfiles/Construction-and%20-demolition-waste.pdf>

[10]http://carbonn.org/uploads/tx_carbonndata/File5_Ahmedabad_SWM.pdf

[3]<http://worldpopulationreview.com/world-cities/ahmedabad-population/>

[4]<http://bbmp.gov.in/documents/10180/512162/MSW+RULES+2000.pdf/7224e973-4d26-4afe-a997-cb4ee63521c2>

[5] http://fsi.nic.in/details.php?pgID=mn_93

Rating Systems:

[6] BEAM Plus 2012 - HK GBC, BEAM Plus for new buildings

[7] BREEAM 2009- SD 5066A: Issue 1.1; Code for a sustainable Built Environment

[8] GRIHA V 2015; TERI

[9] LOTUS 2015; Vietnam Green Building Council, LOTUS Non Residential Rating Tool V2.

[10] Materials & Resources BD+C.pdf

[11] Pearl 2010 - The Pearl rating system for Estidama, Design and Construction, V 1.0

INDOOR ENVIRONMENTAL QUALITY

CATEGORY 6: Indoor Environment Quality (12 POINTS)

IDENTIFICATION OF ISSUES:

1. Air pollution is extremely high in the city
2. Need to address noise masking in commercial complexes
3. Due to extreme temperatures, comfort levels of the occupants need to be taken care of.

OVERVIEW

The LEED manual for (indoor) environmental quality states “Minimum Indoor Air Quality Performance” as a prerequisite to qualify for this category. Indoor air quality is affected by outdoor air, when the space is mechanically and/ or naturally ventilated. The following figures give a brief and general idea of the air condition for the city of Ahmedabad, and how it compares to 5 other Indian cities [4].

	Pune	Chennai	Indore	Ahmedabad	Surat	Rajkot
Study domain size (km x km)	32 x 32	44 x 44	32 x 32	44 x 44	44 x 44	24 x 24
Longitude (degrees)	73°48'E	80°16'E	75°32'E	72°35'E	72°50'E	70°47'E
Latitude (degrees)	18°28'N	13°52'N	22°25'N	23°02'N	21°10'N	22°18'N
Land-Sea Breeze	NO	YES	NO	NO	YES	NO
Elevation (meters)	560	7	550	53	13	134
domain Population (million)	6.5	8.5	3.3	7.8	5.0	1.4
City area (square km)	450	1,200	134	700	105	310
Number of monitoring stations	5	6	3	6	3	2
Annual average PM ₁₀ (µg/m ³)	60-160	60-120	60-170	80-100	75-100	80-120
PM _{2.5} measurements	Limited	Limited	NO	NO	NO	NO
Vehicle Fleet (millions)	2.3 (2008)	3.8 (2010)	1.2 (2010)	1.4 (2010)	1.3 (2007)	1.1 (2010)
(numbers rounded) Cars and Jeeps	323,400	565,350	127,300	213,500	132,750	126,700
2 Wheelers	1,708,100	2,986,600	907,000	1,038,000	1,063,000	878,000
3 wheelers	66,500	55,400	14,000	65,500	65,400	8,860
Buses + Stage Carriers	15,100	15,600	35,200	5,400	1,900	79
HDV + LDV + Others	151,730	123,920	93,200	75,860	69,840	46,900
Power plants	NO	YES (2)	NO	YES (2)	YES	NO
Brick Kilns (number)	400	600	120	320	200	-
2010 PM ₁₀ emissions (tons/yr)	38,400	50,200	18,600	31,900	20,000	14,000
2010 PM _{2.5} emissions (tons/yr)	18,000	24,600	10,400	19,300	12,000	7,800
2010 CO ₂ emissions (mil tons/yr)	15.2	31.6	9.4	22.4	11.8	7.4
Estimated Premature Deaths	3,600	3,950	1,800	4,950	1,250	300
Mortality per ton of PM ₁₀	0.1	0.07	0.1	0.14	0.06	0.02
Mortality costs (million USD)	151	165	75	207	52	13
Morbidity costs (million USD)	246	269	122	336	85	21
2020 PM ₁₀ emissions (tons/yr)	38,000	55,100	21,000	31,800	23,200	18,500
Estimated Premature Deaths	4,300	6,000	2,500	7,850	2,050	670
PM ₁₀ emissions reduced under six interventions (tons/yr)	13,900	17,400	6,200	8,800	8,200	7,900
% compared to 2020 baseline	37%	31%	30%	27%	35%	42%
Premature deaths saved	1,700	1,270	630	1,390	590	290
% compared to 2020 baseline	39%	21%	25%	18%	29%	42%
Mortality savings (million USD)	71	53	26	57	24	12
Morbidity savings (million USD)	114	87	44	94	40	20
CO ₂ emissions reduced under six interventions (million tons/yr)	3.0	5.7	1.8	2.5	2.4	1.4

Table 16: Air Pollution analysis summary, for 2010

The city is bisected by the river Sabarmati, in two parts: the east (old city and industries) and the west Ahmedabad (new commercial areas and business districts). Western Ahmedabad grew due to the increasing city population (about 1.1 million people in 1961 to 7 million in 2014 [12]). And with increasing population came more “urban services” like schools and other educational institutes, more business districts, commercial shopping complexes and housing. Ahmedabad had around 66 textile mills at one time [4].

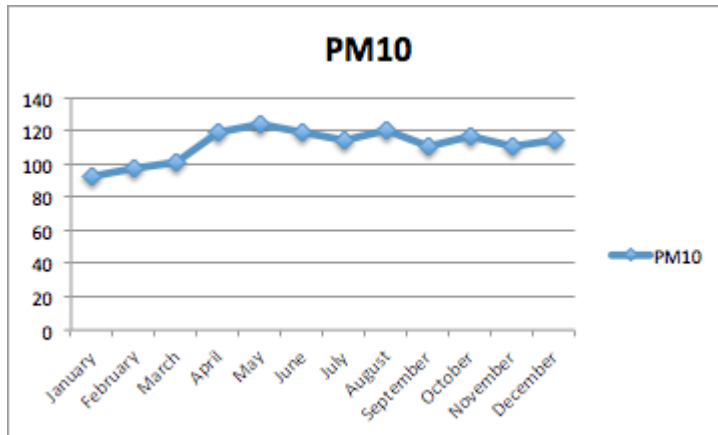
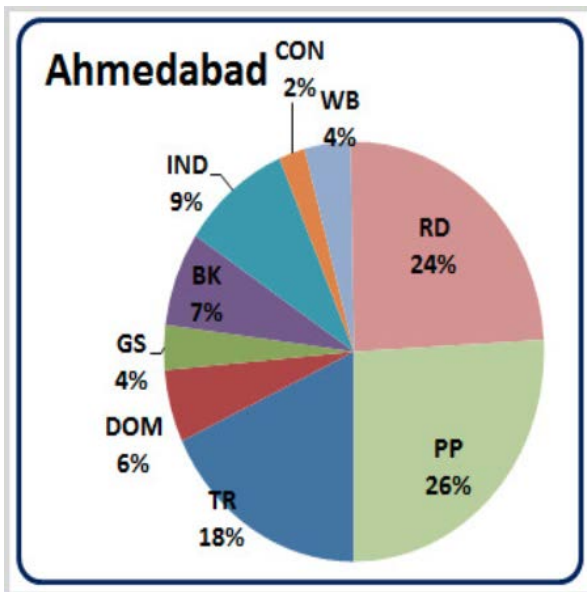


Chart 17: PM10 concentrations for 2010, as given by Guttikunda and Jawahar, 2012 and recreated/ charted by authors



Plotting a chart for measured average PM10 values on a monthly basis, we find that it is the months of June and October that record the highest number (June: 118.8, October: 116 micrograms/ cubic meter). The annual ambient standard is 60 micrograms/ cubic meter. [4] Ahmedabad also has very limited data for PM2.5 values, with the annual ambient standard being 40 micrograms/ cubic meter. [4]

Chart 2: Types of PM 10 emissions categorised for 2010. VEH: vehicle exhaust; DOM: domestic cooking and heating; IND: industries, including brick kilns; GS: diesel generator sets; CON: construction activities; WB: waste burning; RD: road dust; and PP: power plants as given by

Guttikunda and Jawahar, 2012.

Guttikunda, in an interview with a leading newspaper was quoted to say, "Ahmedabad has a high level of PM10. Here, pollution comes from a variety of sources - power plants and brick kilns surrounding the district. We often believe that vehicles moving in immediate surroundings

contribute to the pollution in cities. However, a plant or a kiln away from the city can also affect Ahmedabad considering the wind direction." He also talked about how the city does not gather sufficient data on PM_{2.5}, and so all suggestions and credits can only be geared towards PM₁₀ values.

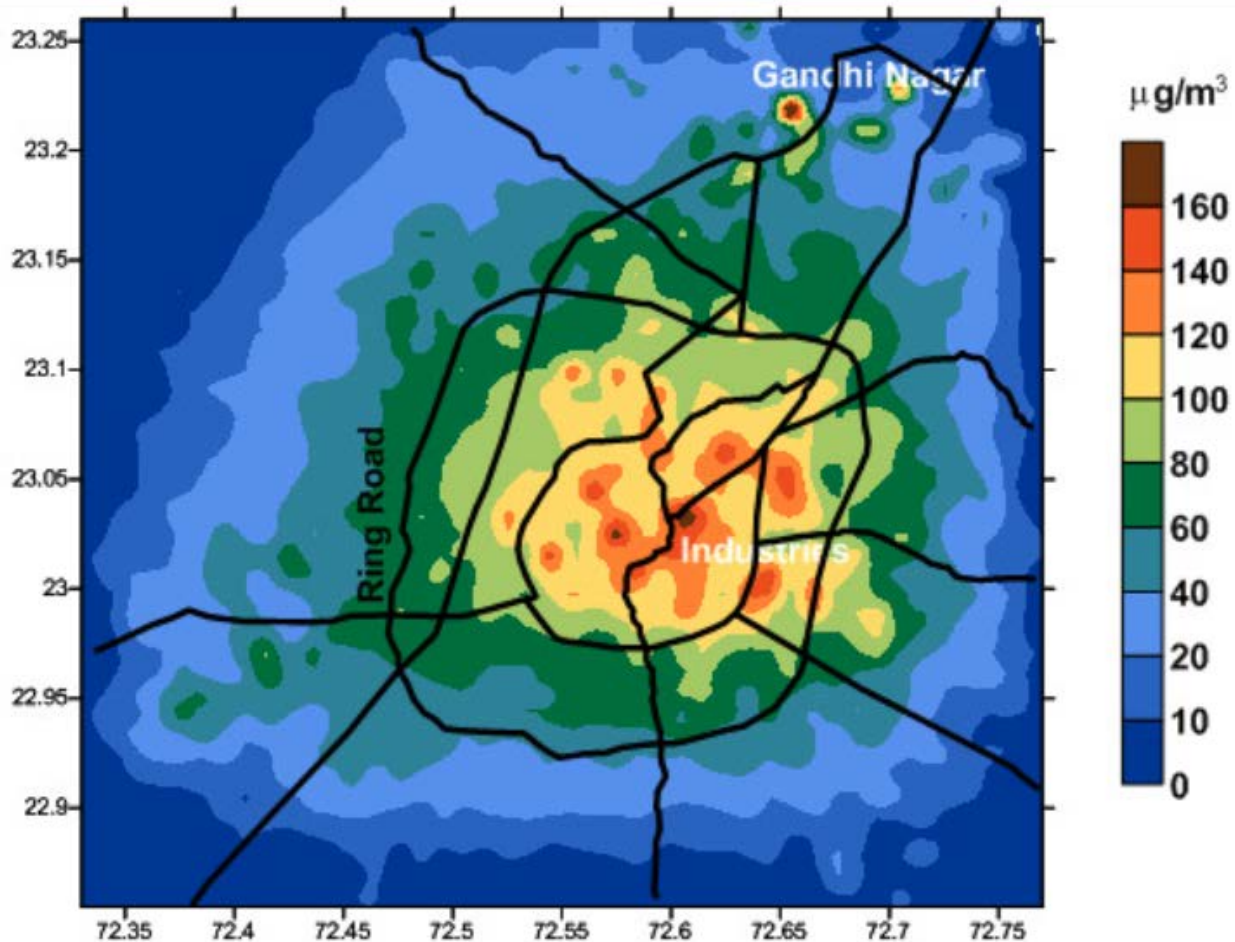


Figure 18: Model estimated annual PM₁₀ concentrations in microgram/ cubic meter for 2010, as given by Guttikunda and Jawahar, 2012

The major cause of PM₁₀ in Ahmedabad is cars (vehicle exhaust), road dust, the burning of garbage and diesel emissions from generator sets [4]. And so, Guttikunda and Jawahar, 2012 did a grid map to look at PM₁₀ emissions from the vehicle exhaust in the city. They found a major concentration of the emissions along the main arterial roads, because they also cater to truck movements.

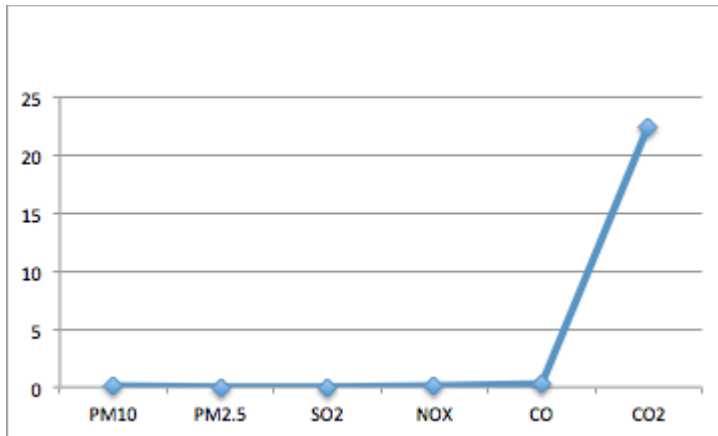


Chart 3: Emissions inventory for 2010, as given by Guttikunda and Jawahar, 2012 and recreated/ charted by authors. The unit is million tons.

While the PM10 value for the year 2010 is 31,900 tons, it is very less than NOx (186,300 tons) and CO (207,000 tons). CO2 is the highest at 22.4 million tons. The low value of PM2.5 may be because the city does not have much data on it [4].

CREDITS:

Ensuring occupants' productivity is done most effectively by maintaining and increasing the building's Indoor Environmental Quality (IEQ). Improving the IEQ results in reduced cases of asthma, allergies, respiratory disease and other occupant ailments described as "sick building syndrome". Reduced absenteeism and increased productivity can translate into reduced costs and increased savings for building owners and operators. Proper IEQ also increase the resale value of any building.

EQ	CREDIT	Description	Points
PR	No indoor smoking	Pre-req to qualify for this category	PRE REQ
EQ1	Indoor Air Quality	Fresh air supply Ventilation Carbon Dioxide monitoring Air Filtration	3
EQ2	Indoor Thermal Comfort Levels	Temperature control for the occupants at required timings.	2
EQ3	Indoor Visual/ Comfort Levels	'Access to nature' as a stress reliever.	3
EQ4	Indoor Acoustic Comfort	Noise prevention strategies	1

	Levels		
EQ3	Hazardous Materials	To discourage use of volatile organic compounds, that would adversely affect human health	3

EQ PREREQUISITE: NO INDOOR SMOKING

Intent:

To ensure the provision of enough fresh air to maintain good indoor air quality during occupancy and avoid contamination.

Requirements:

Criteria	Points
Prohibit smoking in the building in accordance with the October 2008 <i>Prohibition of Smoking in Public Places Rules, 2008</i> and COTPA	Pre req

Behind the intent:

According to the [World Health Organization](#) (WHO), India is home to 12% of the world's smokers. Approximately 900,000 people die every year in India due to smoking as of 2009. Tobaccoatlas.org, pegs percent of smoking related male deaths at 14.35%, and 4.68% female deaths. Both the values are for the year 2010. The Supreme Court of India had first ruled in favour of smoking ban in 2001. The problem becomes when builders do not enforce the ban, in an effort to gain more patronage [10]. This makes it imperative to have a smoking ban in the building as a prerequisite.

Approach:

1. Users to be made aware of the smoking ban by displaying "No Smoking" signs (in areas of prominence that may be frequented by smokers, stairwells and balconies).
2. Building may be allowed to install smoking sections inside the building. They should have operable windows and should be equipped with individual fire fighting equipment.
3. Designated smoking areas must be located at least 25 feet (7.5 meters) from all entries, outdoor air intakes, and operable windows.

Compliance:

1. Design stage site plan indicating the location of designated smoking areas; with mechanical drawings showing the ventilation system for the designated smoking areas

- inside the building
- 2. As-built stage site plan annotated to indicate the location of designated smoking areas

EQ1 : Indoor Air Quality

Intent:

To regulate indoor air quality by strategic measures that ensure CO2 reduction and fresh air circulation.

Requirements:

Criteria	Points
<i>IAQ monitoring</i>	1
Monitoring the CO2 , temperature and RH at the occupied spaces or at AHUs for the air conditioned spaces, pre and post occupancy	
<i>Fresh air supply to about 95% of occupied space</i>	2
Meet the minimum requirements of	
1. CPCB National Ambient Air Quality Standard (NAAQS)for quality of fresh air; and ASHRAE Standard 62.1–2010, Sections 4–7, Ventilation for Acceptable Indoor Air Quality (with errata), (1 point)	
OR	
2. National Building Code-2005 for quantity of fresh air.	

Behind the intent :

The city has high levels of particulate matter in the air. Within a commercial building, the most common particles are tobacco smoke, carbon dioxide, allergens and other dust. For this city, we will assume the IAQ to be based on CO2 measurements and PM10 data. The clauses shall cover treatment of outdoor air for PM10, Ozone and CO2 and air flow rate.

Approach:

1. Selection of ventilation strategy according to the requirement of the project
2. For mechanically ventilated spaces,minimum outdoor air inflow rate should be between 8-15 l/s.
3. For naturally ventilated spaces,minimum opening area should be determined according to building design as given in National Buidling Code, Bureau of Indian Standards–2005, Part VIII–Building Services, Section 1–Lighting and Ventilation Section 5.4.3.1.
4. For mixed mode ventilation, the system should comply with natural ventilation requirements when it is active and the same for mechanical ventilation as well.
5. Installation of CO2 Sensors and filters as per National Building Code 2005 Bureau of

Compliance:

1. Submit documentation detailing the specifications of the filtration system to demonstrate that fresh air quality meet the minimum requirements of CPCB NAAQS
2. Submit space by space sheet Heat Load Sheet highlighting provision of sufficient fresh air in the HVAC system design as per the ASHRAE 62.1 or NBC 2005 Part VIII norms
3. Submit drawings (floor plans and/or HVAC system plans) highlighting the location of various CO₂ , temperature and RH sensors
4. Submit purchase orders (reflecting full quantities) for the filters and sensors installed in the project.

EQ2 : INDOOR THERMAL COMFORT LEVELS:

Intent:

To insure comfort level is maintained in the interior, by taking into account thermal properties in the design and specifications.

Requirements:

Criteria	Points
Thermal Comfort: OPTION A 95% of the occupied spaces shall meet one of the following requirements: Air-conditioned and mixed-mode ventilated spaces: designed to maintain an indoor operative temperature between 24°C to 26°C and a relative humidity below 70% during occupied hours. [6] Non air-conditioned spaces meet the requirements of Section 5.3 of ASHRAE 55- 2004 with indoor operative temperature at design conditions in the 80% acceptability limits. [3]	2
OPTION B Demonstrate that project can achieve the thermal comfort requirements of National Building Code 2005 OR ASHRAE 55 OR requirement of Indian Adaptive Comfort Model [3]	2

Behind the Intent:

Thermal comfort is stated to be a state of mind, which makes us feel comfortable with our surrounding thermal environment “and is assessed by subjective evaluation” [2]. This condition of being comfortable. or rather, being satisfied with the thermal environment depends on the heat generated by occupants of a space equalising with the heat dissipated from that space,

maintaining equilibrium. Since thermal comfort has a direct relation to health [7], it is of utmost importance for designers and architects to maintain thermal comfort levels in their buildings. Thermal comfort depends on our own perception of comfort and personal factors (metabolic rate and clothing level) and the environment, it depends on a lot of factors like air temperature and its speed, humidity and mean radiant temperature. It can be achieved through either design strategies or/ and mechanical cooling and ventilation.

Approach:

1. Utilizing design strategies like
 - a. Building atria
 - b. Window arrangement
 - c. Open plan design [6]
2. Effective building envelope to promote heat loss through convection/ radiation/ conduction [3]
3. Properly designed efficient air-conditioning system [3]
4. Appropriate thermal zoning
5. Enhance indoor air velocity using fans or through carefully designed natural ventilation
6. Limit solar radiation on glazing by installing effective external shadings on windows to control radiant temperature
7. Limit solar radiation on opaque walls and roofs
8. Limit internal heat gains (from artificial lighting and equipment) [3]

Compliance:

1. Submit drawings (floor plans, relevant elevations and sections and doors-windows schedule) for the project, detailing various shading devices.
2. Submit simulation reports to demonstrate that thermal comfort conditions as specified in credit are met in the project.
3. Submit specification sheets, purchase orders (reflecting full quantities) and BOQ of relevant products used in building for thermal insulation.

EQ3 : INDOOR VISUAL COMFORT LEVELS:

Intent:

To increase the occupants connection to the outdoors by ensuring direct line of sight to the exterior. [6]

Requirements:

Criteria	Points
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Visual: Daylight Minimum of 25% of the habitable area should meet adequate level of daylight (daylight factors) as prescribed in SP 41 [3] If the adequate daylight factors are achieved in more than 50%/75% of total habitable area 1 point for every additional 15% of the net occupied area has an average daylight factor between 1.5% and 3.5% (Up to 80%) [3] Artificial lighting design to fall within limits (minimum and maximum) as recommended space/task specific lighting levels as per National Building Code and to meet a minimum uniformity ratio of 0.4 [3]	2 1 1
Visual: Access to quality views Option A: 65% of the net occupied area achieves a direct line of sight to the outdoor environment via vision glazing [6] 80% of the net occupied area achieves a direct line of sight to the outdoor environment via vision glazing [6] Option B: 65% of the net occupied area achieves a direct line of sight to the outdoor environment via vision glazing AND has quality views: views that include at least two of the following: ● flora, fauna, or sky; ● movement; and ● objects at least 25 feet from the exterior of the glazing [11]	2

Behind the Intent:

Windows and openings provide a direct connection between the building's occupants and the outdoor environment. This connection improves occupants' wellbeing, which can lead to increased health, comfort and productivity.

Daylighting involves the introduction of natural light, as opposed to artificial light, into an occupied space. This increases building occupant comfort while reducing the energy required for lighting. When designing for natural light, designers must balance many factors, such as solar heat gain, glare, light availability, visual quality and occupant requirements.

Approach:

1. Utilizing design strategies like
 - a. Building atria
 - b. Window arrangement
 - c. Skylights

- d. Interior light shelves
- e. Open plan design [6]
- 2. Locating open areas near the perimeter of the building [6]
- 3. Locating unoccupied spaces within the core of the building [6]
- 4. Locating glazing at appropriate height to provide line of sights [6]

Compliance: [3]

- 1. Submit drawings (floor plans, relevant elevations and sections and doors-windows schedule) for the project, detailing various shading devices.
- 2. Submit simulation reports (in the prescribed format) demonstrating that at least 25% (or more) of total habitable area/ net occupied area of project meets daylight factor requirements of SP 41
- 3. Submit simulation reports (in the prescribed format) demonstrating that at least 25% (or more) of total living area of project achieves 100% UDI (100-2000 lux) limits for all occupied annual daylight hours.
- 4. Submit artificial lighting simulation reports demonstrating that the artificial lighting levels meet the National Building Code 2005 Bureau of Indian Standards–2005, Part VIII– Building Services, Section 1– Lighting and Ventilation recommended levels and uniformity of 0.4
- 5. Submit interior artificial lighting layout drawings
- 6. Submit specification sheets, purchase orders (reflecting full quantities) and BOQ of relevant products used in building for glass specifications, Interior lamps and luminaires.

EQ4 : INDOOR ACOUSTIC COMFORT LEVELS:

Intent:

To insure acoustic comfort level is maintained in the interior, through building design and specifications.

Requirements:

Criteria	Points
Acoustic Comfort: The indoor noise levels should be within the acceptable limits as specified in National Building Code 2005 and key noise source on site (like DG sets, chiller plants etc.) should have sufficient acoustic insulation as per NBC 2005 norms	1

Behind the Intent:

Acoustic comfort is measured by the amount of noise in a space, in decibels. With noise pollution on a steady rise, the NBC has ended up defining what is the acceptable level of noise in areas having particular activity.

Approach:

1. Locating noise buffer spaces within the building, to mask noise of HVAC systems
2. Providing acoustic masking through low level back ground noise (less than 40dB, according to National Building Code, Bureau of Indian Standards–2005, Part VIII– Building Services, Section 4–Acoustics, Sound insulation and noise control)

Compliance:

1. Submit drawings and narratives highlighting various measures adopted to meet indoor noise levels of NBC 2005 and to limit noise from noise sources mentioned in credit
2. Submit specification sheets, purchase orders (reflecting full quantities) and BOQ of relevant products used in building for acoustic insulation.

EQ5: Hazardous Material

Intent:

To discourage use of volatile organic compounds (VOC) emissions into indoor air to avoid damage to human health, productivity and the environment.

Requirements:

Criteria	Points
Low VOC content materials in either one of the following points: 1. Paints and coats 2. Adhesives and sealants 3. Flooring and Furniture [3]	1
Bonus points (2 max) if more than one points is satisfied	+2

Behind the intent :

VOCs are emitted from a variety of products (e.g. paints and lacquers, paint strippers, cleaning supplies, building materials and furnishings, many office equipments). Hence, concentrations of VOC's on the inside of the building are high, which affect occupant health. Talapatra and Shrivastava 2011 report VOC values in the three digits (90-300 micrograms/ cubic meter). Another harmful substance usually found in buildings is formaldehyde. It is most commonly found in pressed wood products like particle boards, hardwood plywood panelling and medium density fibreboard, which use adhesives that contain urea-formaldehyde (UF) resin or phenol-formaldehyde (PF).

Approach:

Use products which are certified as low VOC and/or low Formaldehydes products by any internationally or regionally recognised authorities (e.g., LEED, European standard organisation, National Building Code and Indian Standard codes). Such products can be chosen from the

following types:

1. Flooring systems
2. Paint and coatings
3. Adhesives and sealants
4. Composite wood products used in furniture [6]

Compliance:

1. Submit specification sheets for the following:
 - a. low-VOC and lead-free paints being used in building interiors.
 - b. low-VOC adhesives, sealants used in building interiors
 - c. composite wood products demonstrating that they do not use urea-formaldehyde as a bonding resin [3]
2. Submit purchase orders (reflecting full quantities) for the above materials [3]

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